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INTRODUCTION.

The work now presented to the Public is the result of laborious investigation during a period of more than Fifty years. The Author in early life turned his attention to Mineralogy, and in his Father's mines had an opportunity of noticing the visible effects of the deluge.

When he had finished his education at Cambridge, and had left the University, he took up his residence in Scotland where his knowledge progressively increased and prepared him for a more extensive field of observation.

In the year 1769 *he traversed Ireland, and the next year he crossed over to the Continent, that he might pursue his researches in Holland, France, and Flanders. In these journies he had an opportunity* *required by Geology, an accurate Survey must be taken of the faults and dislocations to which each Stratum has been subject.*

This Task Mr. Farey has accomplished in Derbyshire, and this Wm. Smith if properly supported will accomplish in every part of England.

Introduction.

CICERO informs us, that many persons have borne the name of Hermes. Among these we find one, whom he describes as the offspring of heaven, particularly distinguished as having been in love with Proserpine; another, who was the son of Jupiter; and a third, who derived his origin from the Nile, but whose name it was not lawful for the Egyptians to utter. Beside these, he makes mention of a fourth worshipped in Phœnicia, who, having slain Argus, fled for safety into Egypt, where he introduced laws and the use of alphabetic characters.*

Pliny and Plato agree in attributing their invention to this Egyptian Hermes, whom the latter stiled a god, and the father of letters.

Cudworth was of opinion, that the first Hermes, who taught the Egyptians mathematics, geometry, astronomy and hieroglyphics, lived a considerable time before Moses; and that the second, whom he considered as the Hermes Trismegistus, flourished in Egypt at least fifty years after the departure of the Israelites. But Gale, on the authority of Artapanus, as quoted by Eusebius, insisted, that Moses and the first Hermes were the same. This opinion is supported by Huet, who traces numerous features of resemblance between them. Hermes was a native of Egypt, had the Nile for his father, and at his birth was admired for his beauty. The lovely Horæ, who attended upon Venus, received and nursed the favoured infant, and Juno herself condescended to give him suck. As this little divinity advanced in years, he constructed a pastoral pipe, tended his flocks, and was himself the deity invoked by shepherds. He distinguished himself as the destroyer of serpents, and round the wand with which he wrought his prodigies, were entwined two of these venomous reptiles, as emblems of his wisdom, and memorials of his power. He was regarded by travellers as their guide and guardian, and even domestic security was attributed to him. He stole thunderbolts from Jupiter, became his messenger, and was the revealer of his decrees to men.

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* Tully, D. N. D. l. 3, § 22.

Thus far our learned Huet; and if, from what he has suggested, any one should be inclined to think, that the history and attributes of Hermes were derived from a confused tradition of the more than human power and wisdom displayed by Moses in his conduct of the Israelites, and in their deliverance from Egypt; he may possibly be confirmed in this opinion, when he considers, that Mercury, or the Egyptian Hermes, and Taautus of the Phœnicians, who beyond question, was the Jewish Moses, are the same person. And should it be allowed, that the most striking incidents in the life of Moses contributed to form the fabulous history and character of Hermes; this will account for the appellation of

Hermopolis being given to a city in Africa, the building of which has been attributed by one author of great authority to Moses, and by another to the Egyptian Hermes.—Between the opposite opinions of Cudworth and Huet it is not my intention to decide. There is much of poetic fiction, much of disguised truth blended in the history of that philosopher, to whom the Egyptians acknowledge themselves indebted for intellectual improvements, and whom, in gratitude for benefits received, they have distinguished by the appellation of *Trismegistus*, that is, thrice the greatest.

The resemblance between him and Moses may be fortuitous; yet such obligations as the Egyptians acknowledge to their Hermes, such, and indeed infinitely greater, were those conferred upon the Jews by Moses. He was in strict propriety of speech *Trismegistus*, the greatest as an historian, the greatest as a law-giver, and the greatest as a prophet. In these respects, therefore, I propose to consider the character of Moses, as derived from his Pentateuch, which contains—1. The history of mankind in the early ages of the world. 2. A code of laws designed for one peculiar people, chosen and cherished as worshippers of the great Creator, and guardians of the lively oracles of truth. 3. Prophecies relating to this chosen race, through the long period of revolving ages, from their first entrance into Egypt, to their final expulsion from the land of promise and dispersion among all the nations of the earth.

Of Moses as an Historian.

CHAP. I.

OF THE GENUINENESS OF THE PENTATEUCH.

THAT the history of the first ages of the world, till the Israelites, after their departure from Egypt, arrived at the borders of the promised land, was the work of Moses, and written by divine authority, must be considered as the foundation of all revealed religion. This therefore is the first truth to be established, and for its support the evidence produced will be taken from the body of the work itself, confirmed by the testimony of succeeding records, which will sufficiently demonstrate the Pentateuch to have been coeval with the civil polity of the Jews, and like it, to have derived its origin from heaven.

In the beginning of Exodus we see, that, according to the will of the Supreme, the most important records were not to be transmitted to posterity by oral tradition, lest they should be either misrepresented, mutilated, or altogether lost. For thus said the Lord to Moses, "Write "this for a memorial in a book;"* and agreeably to this command, we find that Moses wrote all the words of the Lord, and taking the book of the covenant, he read it in the ears of the people.† His last most solemn act was to deliver a copy of the law to the priests the sons of Levi, and to all the elders of Israel, with this strict injunction: "At the "end of every seven years, in the solemnity of the year of release, in the "feast of tabernacles, when all Israel is come to appear before the Lord "thy God, in the place which he shall choose; thou shalt read this law "before all Israel in their hearing. Gather the people together, men, "and women, and children, and thy stranger that is within thy gates, "that they may hear, and that they may learn, and fear the Lord your "God, and observe to do all the words of this law; and that their children, which have not known any thing, may hear and learn to fear the "Lord your God, as long as ye live in the land, whither ye go over "Jordan to possess it."‡

In all the sacred writers, who succeeded Moses, we meet with multiplied references to, and quotations from, these volumes.

Joshua, his immediate successor, was charged to meditate day and night in the book of the law, in order that he might observe to do according to all that is written therein, and that his way might prosper.§ Agreeably to this injunction we find it testified of him, that, as the Lord commanded Moses his servant, so did Moses command Joshua, and so did Joshua. He left nothing undone of all that the Lord commanded

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* Ex. c. 17, v. 14. c. 34, v. 27. † Ex. c. 24, v. 4, 7. ‡ Deut. c. 31, v. 9—13. § Josh. c. 1, v. 8.

Moses.* When he entered into office, he inscribed a copy of the law on stone, in the presence of the people; and before his death, after he had divided Canaan among the tribes of Israel, his last exhortation was delivered in these words: "Be ye therefore very courageous to keep and "to do all that is written *in the book of the law of Moses*, that ye turn "not aside therefrom to the right hand nor to the left."†

The authority of Joshua, and the authenticity of his relations, stand upon the surest ground, and give a firm support to the veracity of the preceding records of his nation. For, not to mention other miracles, the passage of Israel over Jordan leaves no room to doubt of his having been commissioned from above. Of this wonderful transaction, he not only drew up a record at the time, which the Jewish nation has preserved, but he erected monuments to confirm that record by the most infallible tradition—a tradition, which by his express command, was to be transmitted, respecting these monuments, from parents to their children throughout all succeeding generations. "On that day the Lord "magnified Joshua in the sight of all Israel, and they feared him as "they feared Moses all the days of his life; and the Lord spake unto "Joshua, saying, Command the priests, that bear the ark of the testi-"mony, that they come up out of Jordan. Joshua therefore com-"manded the priests, saying, Come ye up out of Jordan. And it came "to pass, when the priests, that bare the ark of the covenant of the "Lord, were come up out of the midst of Jordan, and the soles of the "priests' feet were lifted up unto the dry land, that the waters of Jordan

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* Josh. c. 11, v. 13.

† Josh. c. 8, v. 32. c. 23, v. 6.

" returned unto their place and flowed over all the banks, as they did
" before; and the people came up out of Jordan on the tenth day of
" the first month, and encamped in Gilgal, in the east border of Jerico.
" And these twelve stones, which they took out of Jordan, did Joshua
" pitch in Gilgal. And he spake unto the children of Israel, saying,
" When your children shall ask their fathers in time to come, saying,
" What mean these stones? Then ye shall let your children know, saying, Israel came over this Jordan on dry land."*

In attestation of this marvellous transaction, we have all the evidence which a lover of truth can possibly require. The men of that generation could have no doubt respecting it. They were fully competent to judge, whether the passage were miraculous or not. They had notice on the preceding day of what was intended. Jordan had overflowed all its borders, and no natural cause could therefore be assigned adequate to the effect produced. Neither could succeeding generations have any room to doubt, because the tradition was uninterrupted, and the monuments are stated, in the record itself, to have been erected at the time. For let us suppose that no such monuments had been erected, or that no such tradition had attended them; it would have been impossible, at any subsequent epoch, when these things should have been introduced, for any one to have persuaded the Jewish nation to believe, that such monuments had existed from the days of their progenitors, or that such a tradition respecting them had been anciently, constantly, and universally received.

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* Josh. c. 4, v. 14—22.

From the days of Joshua to the expulsion of his nation out of Judæa, frequent mention is made of Moses, either to enjoin obedience, to blame the people for their neglect, or to commend them and their monarchs for their observation of his law. Thus, for instance, in the book of Judges it is said, that some idolatrous nations were left unsubdued among them to prove Israel, and to know whether they would hearken unto the commandments of the Lord, which he commanded their fathers by the hand of *Moses.** Thus also when David was dying, he charged Solomon his son, saying, " I go the way of all the earth: be " thou strong therefore, and shew thyself a man; and keep the charge of " the Lord thy God, to walk in his ways, to keep his statutes, and his " commandments, and his judgments, and his testimonies, as it is *written* " *in the law of Moses*, that thou mayest prosper in all that thou dost, " whithersoever thou turnest thyself."† In the reign of Amaziah it is said, " He did that which was right in the sight of the Lord, yet not like David " his father: he did according to all things as Joash his father did. " And it came to pass, as soon as the kingdom was confirmed in his " hand, that he slew his servants that had slain the king his father. But " the children of the murderers he slew not; according to that which " is written in the *book of the law of Moses*, wherein the Lord commanded, " saying, The fathers shall not be put to death for the children, nor the " children be put to death for the fathers; but every man shall be put " to death for his own sin."‡ Subsequent to this we find Manasseh blamed and threatened by the prophets of his day, for not observing to do according to all that God had commanded, and according to all that his servant *Moses* had appointed. But of his grandson Josiah it is said, that there was no king before him, who turned to the Lord with all his heart, and with all his soul, and with all his might, according to all the *law of Moses*; neither after him arose there any like him.*

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* Judg. c. 3, v. 4. † 1 Kings, c. 2, v. 3. ‡ 2 Kings, c. 14, v. 3—16.

So much for the testimony of historians, in succession, from the departure of Israel out of Egypt, to their captivity in Babylon. A similar testimony is borne by all the prophets, both before and after the captivity; by Isaiah, by Jeremiah, by Daniel, and by Malachi, whose last and farewel admonition to the church of God, which closes the prophetic writings, is in these words, "Remember ye the *law of Moses* "my servant, which I commanded to him in Horeb."†

The laws of the Jewish people, whether municipal, moral, or ceremonial, are so interwoven, so intimately blended with, and dependant on their history, that the genuineness of both must either be acknowledged or rejected, for they cannot be separated. If, therefore, it be allowed, that their laws are the genuine laws received from Moses; it will follow, that so likewise are the first records of their nation. But infidelity itself, not even the most sceptical, ever doubted whether the Mosaic code were genuine or not, for it has been universally received as such. Consequently the historical relations, on which those laws are founded, and which have constantly attended them, must be allowed to have made good their claims, and must be received as genuine.

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* 2 Kings, c. 21, v, 8. c. 23, v. 25.

† Malachi, c. 4, v. 4.

In the concession which it makes, infidelity is wise, because the most credulous can never be persuaded to believe, that a nation at any time would renounce its laws, and adopt new ones, as the laws by which they and their fathers had been for ages governed. But in denying the consequence which flows from this concession, infidelity must never boast of wisdom, for who can imagine, that the institutions of the Sabbath, of the Pentecost, and of the Passover, had any other origin than those which the Jewish historian has attributed to them. They were, in fact, like the other solemnities, historical records of remarkable events, and, at these great festivals, appropriate songs, composed by the most eminent among the prophets, reminded the Jewish people of those wonderful deliverances which a watchful providence had vouchsafed to their progenitors. But it was not merely at the great festivals that these things were brought to their remembrance, for the psalms of David, which, during his reign, and in all succeeding generations, formed the devotional and daily exercise of their church, frequently refer to, and sometimes take occasion to repeat, the most interesting narratives which are recorded in the Pentateuch.

Such evidence is irrefragable. But if, in confirmation of this, we reflect on the early defection of the ten tribes under Jeroboam, with the jealousy subsisting between them and the two remaining tribes of Benjamin and Judah, we must be satisfied that no such understanding and consent could subsist between them, as would be injurious to the purity of their sacred records.

If we consider likewise, that, after the return from Babylon, mutual hatred and contempt produced a total want of communication between the Jews and the Samaritans, in consequence of which the latter became guardians, and watchful guardians, of their Pentateuch; if we call to mind how widely the Greek translation of the Septuagint was diffused; and if we concede, as we inevitably must, that these scattered copies of the law essentially agree; and finally, if we take into consideration the mutual jealousy of the Pharisees, the Sadducees, and the Essenes; may we not with the strongest confidence affirm, that we possess the writings of Moses genuine, and to every useful purpose, in their primitive perfection?

CHAP. II.

OF THE CREDIBILITY OF THE MOSAIC HISTORY.

SECT. I.

The credibility of the Mosaic history proved by internal evidence.

HAVING established on a firm foundation the genuineness of the Mosaic history; let us next examine how far Moses was qualified, whether in point of knowledge or integrity, to relate the events recorded in his Pentateuch.

With regard to his knowledge it may be sufficient to inquire, in what manner he could have gained information, respecting the transactions which preceded those in which he himself was immediately engaged.

The education he received in Egypt, that nursery of the arts and sciences, must naturally have improved his understanding, and the conversation of his pious ancestors must have made the great events, in which their fathers were concerned, familiar to his mind. Of these progenitors we need only mention four, Methuselah, Shem, Isaac, and Joseph. Shem lived near a hundred years with Methuselah, who was for centuries cotemporary with the first parents of mankind; and Isaac, who was born fifty years before the death of Shem, lived many years after the birth of Joseph, between whom and Moses there was the short interval of sixty years. Now, as it cannot be doubted, that in this sacred line the most important truths were delivered in succession from one generation to another, it is clear, that, although the Jewish historian should have had no other assistance but tradition, he would have been perfectly competent to record the principal facts contained in the beginning of his Pentateuch.

Yet, from whatever source he derived his information, we may be satisfied, that one so highly favoured with divine communications could neither invent nor propagate a falsehood. His veracity can scarcely be called in question, because it is impossible to assign a motive which could induce him to deceive. He had no ambitious views. Nurtured in the luxuries of the Egyptian court, he preferred the wilderness; he chose rather to suffer affliction with the people of God, than to enjoy the pleasures of sin for a season. Accustomed as he had been to the splendour which surrounds a throne, he yet declined the regal power, which he might have readily assumed, and have transmitted to his children. Nay, so far was he from wishing to aggrandize his family, that, in the division of Canaan, he gave them no inheritance; but ordained, that they should be merely servants of the altar.

In his narratives we discover no disguise, no palliation of his own imperfections, no apology for the misconduct of his brother, no concealment of the crimes committed by his ancestors. In his address to those whom he was leading to the promised land, no flattery appears. Nay, so far was he from adulation, that he reproaches them for their obstinacy, ingratitude, rebellion; and makes them the guardians of those records, in which he indelibly engraved their shame. In one word, all his writings manifest integrity, for in all we may discern the utmost simplicity, and a strict regard to truth.

Hence then, as an historian, had he none but human authority, he might demand the attention of mankind. But his claims rise higher. He comes to us in the name of Jehovah, and in proof of his divine legation, he appeals to heaven. The miracles he performed in Egypt were such as carried conviction to the mind of Pharaoh, of his wise men, and of all his people. And indeed it was impossible for them to doubt, whether or not, at his command, total darkness continued for three days over all the land; whether locusts came in obedience to his word; whether at midnight all their first-born were smitten, both of man and beast; or whether such prodigies could be produced by any power less than that of the Almighty.

As it was impossible for the Egyptians to doubt, when they beheld such things; much less could the Israelites themselves be inclined to call in question the presence and power of Jehovah, when, as their deliverer, he wrought these signs in Egypt, and these wonders in the land of Ham. Indeed, without such a display of power, it would not have been possible for Moses to have delivered them from bondage, nor could he have prevailed on them to quit the land of Goshen, and to follow him in the wilderness, where no human foot had ever trodden.

Here it will be readily allowed, that had not their eyes beheld these things; had they not seen the waters of the Red Sea divided at his command; he never could have persuaded them to receive it as a fact. For surely no one can imagine, that an impostor could by any means have taught them to believe, that with six hundred thousand souls, attended by their flocks and herds, they had passed safely through the sea, whose returning billows overwhelmed their enemies. Surely they were competent to judge, when, at Horeb, they were perishing with thirst, whether or not water gushed out of the smitten rock for their relief; or whether, when they wandered in the desert, they were, during forty years, fed abundantly with manna. The relator of these facts does not appeal to them as having been accomplished in former ages, but addressing himself to those who had been spectators of his miracles, he saith, “ I speak
“ not with your children, which have not known, and which have not
“ seen the chastisement of the Lord your God, his greatness, his mighty
“ hand, and his stretched-out arm, and his miracles, and his acts, which
“ he did in the midst of Egypt unto Pharaoh, king of Egypt, and unto
“ all his land; and what he did unto the army of Egypt, unto their
“ horses and to their chariots, how he made the water of the Red Sea to
“ overflow them as they pursued after you, and how the Lord hath
“ destroyed them unto this day; and what he did to you in the wilder-
“ ness, until ye came unto this place; and what he did unto Dathan
“ and Abiram, the sons of Eliab, the son of Reuben, how the earth
“ opened her mouth and swallowed them up, and their households, and

" their tents, and all the substance that was in their possession, in the
" midst of all Israel. But your eyes have seen all the great acts of the
" Lord, which he did.*

As it is to the last degree improbable, that the men of that generation, in such facts, should have been deceived; so is it impossible, that any succeeding generation should have been persuaded, had it not been true, that the authentic record of these facts was in their possession, and had descended to them by inheritance from their fathers.

But, will scepticism expect something more for the removal of its doubts? Will it require that a solemn festival, to be celebrated annually in commemoration of the event, should have been instituted at the time, and should have been constantly observed by successive generations? Nay, will it insist, that the record should carry in its bosom an account of the institution? All this may be found in the celebration of the Passover, and the historical account of the great event it was intended to commemorate. For would it have been possible, at any time, to have persuaded the Israelites, that they and their fathers had constantly, from age to age, observed this festival in remembrance of their deliverance from the sword of the destroying angel, when he passed through the land of Egypt, to smite all the first-born, both of man and beast, if no such deliverance had been ever wrought; or if such festival in commemoration of that deliverance had not been, as stated in the record, instituted at the time to which it referred? Indeed we may remark in general, that in the Jewish economy, the principal institutions either look back as records to their deliverance from Egypt, or forwards, as I shall hereafter prove, to a more wonderful event—their deliverance, not from the yoke of earthly tyrants, but from the guilt, and from the dominion of their sins. The latter, as being prophetical, have that degree of obscurity attached to them which is suitable to symbols directing the attention of free agents to future and contingent events. But the former, with such clearness and precision, expressed the occasions on which they were ordained, that it must have been utterly impossible for an impostor, at any time, to have ascribed a different origin to them.

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* Deut. c. 11, v. 2—7.

It is thus demonstrable, that neither could Moses himself deceive the people, nor, in after ages, could any one invent an idle tale, and pass it on the Jewish nation as a truth long established, well known, and universally received. His divine legation being thus established on a firm foundation, whatever he has related we may implicitly believe.

SECT II.

The credibility of the Mosaic history proved by external evidence.

IN order to demonstrate the credibility of the Mosaic history by external evidence, we must bring forwards the various facts, as stated by Moses, and compare them, either with written records and the testimony of prophane authors, who could have no inclination to mislead our judgment; with oral traditions, diffused among civilized and savage nations; or with the state of the world, and with appearances in nature, which cannot possibly deceive us.

In prophane authors we find not only honourable mention made of Moses, but quotations from his Pentateuch. And in all nations we meet with traditional reports relative to the principal events, the distinct remembrance of which has been preserved by him. Most of these, indeed, are mutilated, distorted, and so blended with fictions, as to become ridiculous for their palpable absurdity. But in the midst of these discordant fictions, the principal facts, in which they all agree, have a striking resemblance to the truth; and in proportion as wise men had communication directly or indirectly with the Jews, we see these events described with greater clearness and precision.

SUBJECT I.

THE CREATION.

MOSES begins his Pentateuch with Creation. He represents the Almighty as calling the world into existence, commanding the light to shine out of darkness, reducing confusion into order, giving form to matter, and bringing forth beauty from the bosom of the deep.

In some degree of conformity to this, Sanchoniatho, Hesiod, and Homer, followed by Aristophanes, and Diodorus Siculus, with Ovid, agree, that the world had a beginning, and consider Chaos as the origin of all things. Yet, with defective information, derived from the patriarchal families, or perhaps collected from the oracles of truth, they mixed wild and extravagant conceits, which led the few who were esteemed philosophers to atheism; but the great mass of the people to the most contemptible idolatry. I shall mention some of their particular opinions.

Sanchoniatho appears to have had a confused notion of an infinite Spirit, involved in darkness, and blended with an eternal chaos. According to him, love, the fortuitous affection of this Spirit, generated motion, and gave form to matter.

For a more full account of his writings, I must refer the reader to Bishop Cumberland, and shall only observe, that our Phœnician philosopher describes the first parents of mankind as the offspring of the earth. He is said to have lived some time about the Trojan war, or three hundred years after the departure of the Israelites from Egypt, and in the composition of his work to have employed the records of *Jerombaal*, a priest of the god Juo, with many sacred inscriptions, collected from the temples. The whole of this work is said to have been translated into Greek by Philo, of Byblos; but the first book only, concerning the Phœnician Theology, has been preserved by Eusebius. Porphyrius, the champion of paganism, endeavours to prove its veracity by its agreement with the Jewish history in the names both of persons and of places. But we have reason to suspect either that Sanchoniatho was not acquainted with the Hebrew tongue, supposing him to have consulted the sacred writings, or that his translator did not understand his author. Yet, notwithstanding, it seems evident, that, confused as are his notions respecting the creation, they were derived originally from authentic records; and that the stream, though turbid, flowed from the purest fountains of the sanctuary.

Hesiod, the earliest of the Greek poets, who wrote about nine hundred and fourteen years before the birth of Christ, is equally at a loss with Sanchoniatho in the science of cosmogony. In his celebrated poem on the generation of the gods, he makes Chaos first in existence; then the extended Earth, with Love. From Chaos he brings *Erebus* and *Night*, the parents of Ether and of Day, and, in his system, the Earth produced the starry firmament, which he conceives to be the blissful residence of the immortal gods. These notions, though false, serve to shew from whence his system originally sprung.

Homer contents himself with calling the ocean the parent of all things, and even of the gods.*

Aristophanes follows in the train of these venerable bards, and proves, that his system was derived by oral tradition from the most remote antiquity; because in him obscure resemblances of truth appear, like distant objects viewed through the medium of an almost impenetrable fog. He informs us that *Chaos, Night,* and *Erebus* existed before all things; that Night, expanding her sable wings, deposited her first egg in the *virgin* womb of Erebus, from which proceeded Love brooding over Chaos, with pinions fluttering like the impetuous whirlwind.—Hence originated first the human race; then the immortal gods.

Here, in addition to the chaotic state, we have an allusion to these words of Moses, "And the Spirit of God moved upon the face of the "waters."† The word which we translate *moved*, conveys to us the image of a brooding hen, as in Milton's expression of "Dove-like sat "brooding on the vast abyss;" or of an eagle "spreading abroad her "wings, and fluttering over her nestlings;" and might therefore suggest to our poet the notion of an egg. Indeed his images perfectly accord with Ereb, which means both a raven, and the approach of night.

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* Iliad, lib. 14, v. 201—246.

† Gen. c. 1, v. 2.

Diodorus Siculus taught in the same school. This philosopher describes a *chaotic* state of the universe, and, deriving all animals from the fermentation of earth with water, supposes them to have been quickened and brought to maturity by the sun; as in Egypt mice were reported to be generated by the solar rays, acting upon the deposits of the overflowing Nile. He tells us, that the animals which had most fire in their constitution, rose up into the air; whilst those which had the greatest abundance of water, became fish; and others, in which terrene particles prevailed, lived and moved upon their kindred earth.

Of the Grecian sages the most ancient was Thales, a native of Miletus in Ionia, but a Phœnician by descent. This wise man, thirsting for information on those subjects which most interest the human race, left his native country and visited the East, whence all his successors derived their choicest treasures of wisdom and of knowledge. He considered water as the first material element, but in addition to this opinion he asserted, that the Mind which formed all things of water, is God.* He supposed that night was before day, or, in the language of Moses, that " darkness was upon the face of the deep," till the Almighty said, " Let there be light." He conceived God to be self-existent and eternal.

This great philosopher enjoyed his reputation for superior wisdom near half a century, and died in the year 548 before the birth of Christ, at the age of ninety-six.

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* Tully, D. N. D. l. 1, § 10.

Some of his disciples, by treading in his steps, and receiving information directly or indirectly from those who were conversant with the sacred records, made near approaches to the truth: but others, disregarding that source of information, and corrupting the doctrines of their master, lost themselves in a maze of folly and of falsehood. They supposed, that animals were produced from earth and water, without the assistance of a Deity. But, as man in his infancy would have been totally unable to provide subsistence for himself; they, in their Zoonomia, contrived, that he should be generated in the intestines of a fish, where he continued till he had acquired strength; after which he was cast out upon the land to seek his food wherever he could find it. As to their gods, for they could not bear to be reproached with atheism, these had the same origin with brutes, and like them, although longer lived, were mortal.

Among the disciples of the Ionian sage we see PYTHAGORAS distinguished for superior talents, and himself the founder of a new sect. He lived at the time when the Israelites, after the capture of Babylon by Cyrus, were returning from Assyria to Jerusalem. The place of his birth was Tyre, but he was educated at Samos, and at the age of eighteen sought instruction at the feet of *Thales*, by whose advice he visited Egypt and the East, every where conversing with the most learned men. Under the protection of Amasis, king of Egypt, to whom he was recommended by Polycrates, tyrant of Samos, he met with every attention he could desire from the priests of Memphis, Heliopolis, and Thebes. With them he continued more than twenty years, after which he spent twelve years in Babylon. It may be readily conceived that a philosopher could not pass through Palestine to Babylon, travelling every where in search of knowledge, without seeking communication with the prophets, priests, and public teachers of the Jews. If we may believe Josephus, we need not have recourse to mere conjecture, for he asserts that the Crotonian sage was not only acquainted with the institutions and opinions of the Jews, but adopted them in his own system. And for this he quotes the authority of Hermippus, who wrote his life.* Let us however take a view of his peculiar doctrines, as distinguished from those of the philosophers who went before him.

We learn from Cyril, that Pythagoras believed and taught that there is one God, the principle and cause of all things in the universe, who illumines, quickens, and animates the whole; the origin of motion, the God from whom all things proceed, and who originally brought them out of non-existence into being. He called this first principle "*The one*," that is, "The self-existent and eternal God;" conveying by these expressions the same notion of the Deity as we find in the name dictated to Moses, "*I am;*"† or in that sentence which is equivalent to it, "I lift up my hand to heaven and say, I live for ever!"‡ The creature of a day can say, I live; but no one, excepting the Supreme, can grasp eternity and say, I live for ever.

From the *Tetragrammaton* of the Jews, he probably derived his *Tetractys*, for it agrees with the ineffable name Jehovah, a word of similar import with the preceding, *I am*, which attributes to the Deity self-existence and eternity. To this almighty Being he ascribes not only the production, but the providential care of the universe, with the preservation of that beauty and order of which he was the cause. Considering God as a spirit, invisible and incorruptible, he, like Moses, condemned the use of images, and taught men to worship in spirit and in truth. He required his disciples, in all their solemnities, after repeated ablutions, to appear in white garments, in order to remind them of that purity without which their services could never be accepted, and particularly cautioned them to approach the Deity with perfect abstraction of thought from all temporal concerns. In his cosmogony he derived the earth, with vegetables and brutes, from *chaos*. He conceived man to have been formed in the image of his Creator, and regarded the soul as incorruptible, because it was infused by the Deity, who is immortal. But then, not being able to conceive how it could exist without a body, he taught its transmigration after death. This notion he probably acquired in Egypt, and, if so, he might have been confirmed in it by the Pharisees, supposing him to have conversed with them in Babylon.

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* Joseph. C. A. l. 1, § 22.

† Ex. c. 3, v. 14.

‡ Deut. c. 32, v. 40.

Notwithstanding these singular advantages, this great philosopher, infected with the prevailing polytheism of the age, either believed or affected to believe in created and in generated gods. The former he worshipped in the sun, moon, and stars; the latter, who were equally the objects of his adoration, were heroes, who had been raised to this high dignity for their great achievements upon earth. With these he placed his demons, as mediators between God and man, intellectual beings with aerial bodies, and immortal as the superior gods, yet subject to like passions as mortal man.

He was the first who rejected the vain title of Sophist, and took the more humble appellation of Philosopher, that is, a lover of wisdom. He taught twenty years at *Crotona* after his return from Babylon, and here he became the founder of the Italian sect.*

Many of his disciples, justly celebrated for their improvements in physics, but inclined to materialism, preferred the wild opinions of Democritus to the sober principles in which they had been instructed by their master, and soon lost themselves in atheism.

EMPEDOCLES, however, not inferior to them in his knowledge of the laws of nature, was not implicated in the charge by which they stand disgraced; for he taught the being of a God, whom he denominated *The One*, as distinct from the material world. According to him, the order and system of the universe was not fortuitous, but was the effect of wisdom, which assigned to every thing not such a place as chance might have allotted, but such as best contributed to the well-being of the whole. In his opinion there exist two worlds, the one purely intellectual, the archetype of the other, which is the object of our senses; and agreeably with this sentiment, he considered the visible sun as the type of an intellectual sun. He taught his disciples the purest principles of morality, and constantly insisted, that every man must be happy who hath his mind stored with the treasures of celestial wisdom; whilst he must be wretched, who disbelieves or doubts the existence of a God. Comparing this great philosopher with those who went before him, and considering how much light was at this time diffused among all nations by the dispersion of the Jews; we can have little doubt respecting the source from which, directly or indirectly, he derived his knowledge. In the natural sciences he was far superior to those who went before him, for it was he who first taught, that the proper criterion of truth is not sense, but reason; that the primary qualities of body are figure, magnitude and motion; that the four elements are not, as was universally imagined, simple, but compounds, consisting of smaller particles or atoms; that nothing can be either produced from, or reduced to, nothing; an axiom thus elegantly expressed by Persius—*Gigni de nihilo nihil, in nihilum nil posse reverti;* that vision and other sensations are produced by a flux of atoms; and finally, that *friendship* and *discord* are the active cause and principle of motion in the universe.

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* August. D. C. D. l. 8, c. 16.—Cudworth, p. 370.—Gale, B. 2, c. 8, § 9.

How remarkable is this expression, if we understand it as meaning the attraction and repulsion of modern philosophy, or the elective attraction of our chemists! That he was acquainted with these powers seems to be evident, because he was persuaded, that without discord the whole material system would become one solid mass. These powers, whatever they were, he considered as dependant on the Deity, who is himself essentially, eternally, immutably *One.*[*]

With this superiority of knowledge, he, like his master, was carried away by the tide of polytheism, and worshipped the host of heaven.

He was born about the middle of the fifth century before the Christian era, at Agrigentum in Sicily.

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[*] Cudworth, 1, p. 391.

Socrates arose about fifty years after Empedocles, and was the first philosopher who cultivated morals as a science. He taught his disciples that the Divinity is self-existent and eternal; omnipresent; invisible; infinite in wisdom, benevolence, and power; that his providence is over all his works; and that, as most exalted, he is the supreme object of adoration. With regard to his cosmogony, he taught, that in the formation of the universe, the Deity *reduced confusion into order*, and gave existence to the inferior gods; that is, to the sun, the planets, and the stars; to whom, when he was dying, he addressed his prayers. In fact, he appears to have been condemned, not for denying a multiplicity of gods, but for vindicating their moral attributes and conduct. The Athenians were pleased with the fictions of their poets, and delighted with their descriptions of the gods. They were fond of these imaginary beings, from the relation of whose wild frolics they derived amusement, and from whose sympathizing frailty they hoped for unlimited indulgence. But when Socrates insisted that these subordinate divinities, like the Supreme, were pure, and that consequently they must require purity of heart and life in all their worshippers; he was regarded with a malignant eye, and they accused him of impiety. He might have taught them, with impunity, any abstract and speculative truth; but when they perceived that his doctrine tended to the reformation of their morals, they took the alarm, and resolved that he should die. In this disposition our modern infidels, I fear, resemble them; being offended not, as they imagine, with the *mysteries*, but in reality with the *morals* of the Christian faith.

Plato, the favourite disciple of Socrates, not satisfied with the instructions of his master, nor with the information to be obtained from the most eminent teachers of his age, who were successors to Thales and Pythagoras in Italy and Greece, followed the example of those venerable sages, and travelled into Egypt, that, like them, he might perfect himself in oriental literature.* He considered the universe as the work of a Creator, the one self-existent and eternal Being, incorporeal, immutable; who by his *word* reduced *confusion* into *order*, and from pre-existent matter, which was *without form*, and destitute of light, brought forth this beautiful system, conformable to eternal ideas subsisting in his mind. The immediate agent of the Deity in this work was the universal *Spirit*, or soul of the universe, which existed before the body, that is, before its elementary principles of fire, water, earth, and air. For, in the Platonic system, the universe is one great animal endued with intellect, and is a visible image of the invisible Creator, who, when he had surveyed his work, and saw that all was good, rejoiced exceedingly.† The earth, according to Plato, was produced before the stars, and night preceded day. In his writings, man is considered as formed from earth, yet resembling the gods in mental qualities; and it is insisted, that to regain this image, he must be holy, wise, and just.

He introduced into his works many allegorical fables, and numerous allusions to the Mosaic account, both of the creation, and of the principal events which befel the human race, till the departure of Israel from Egypt.

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* August. D. C. l. 8, c. 4.

† v. Stillingfleet, O. S. l. 3.

He divided his republic into twelve tribes, and took many of his laws from the Jewish code. Such are those respecting servitude, the restitution of stolen goods, the nocturnal thief, and the vicious ox.* He held a divine providence, and taught the immortality of the soul, with a future state of retribution after death. He was the first philosopher who instructed men in the love of God, pronouncing him alone worthy to be called wise, who, knowing and loving God, strives to imitate his perfections, and finds happiness in him. In this enjoyment he taught his disciples to expect their supreme felicity, which is to be found neither in wealth, nor in the fading honours, nor in the fleeting pleasures of this world—but in God.

This distinguished philosopher diffused, like the morning star, his bright effulgence over the Gentile world, and prepared it for the rising of the Sun of Righteousness. Yet in his radiant orb we discover the dark spots of polytheism, for even Plato led his disciples to the altars of the sun, of the stars, of the planets, and even of the earth, which he conceived to be endued with intellect, and to be the oldest of the gods. Nay, he required them to offer sacrifice to demons, who were supposed to have aerial bodies, and to be intermediate beings between the gods and men; immortal, like the gods, yet subject to the same turbulent and brutal passions which torment the human race.

The system, however, of his followers respecting demons did not perfectly accord with his. Some were of opinion that they were, without distinction, gods, and proper objects of adoration. Others distributed them into classes of good and bad, happy and unhappy; and as, according to Plato, there is no felicity without goodness, nor deity without eternity and bliss; they concluded, that only the good demons in reality were gods; yet notwithstanding this conclusion, they offered sacrifices to all—to the good, for their protection; to the evil, that these malignant spirits might not do them harm.

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* Aug. C. D. l. 8, c. 9.

Until Christianity had dispelled the gloomy apprehensions of a benighted world, even the most enlightened philosophers imagined that the Deity was too pure to be approached by mortals, and that demons, as their proper mediators, were ordained to transmit their prayers and their oblations, their incense and the smoke of their sacrifices, to heaven, and to reveal the will and pleasure of the gods to man. Under this persuasion, demons became the principal objects of attention. Plato himself calls them mediators and generated gods, who partake of dominion with the Supreme. The doctrine of demons* was not his own invention, and he no where pretends to have made this discovery himself. He received it, therefore, by corrupt tradition from the Jews, whose pious ancestors regarded angels, not as objects of adoration, but as *messengers* from heaven, for such is their appellation both in the Hebrew scriptures and in the Greek. From this simple notion of intermediate beings, the Syrians derived the worship of their *Baalim.* Somewhat similar to these were the hero gods of the Greeks, by Plato stiled *demons*, and by the Romans, *dii manes;* of whom, such as were good received the name of *lares*, leaving the appellation of *larvas* to the evil. These last were the *nocturnal lemures* of Horace, and the *black lemures* of Persius, so distinguished because they were incessantly engaged in dark and mischievous designs.

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* 1 Tim. c. 4, v. 1.

In these demons originate the good and evil *genii* of the Arabs, the *peris* of the Persians, from which are derived our *fairies*, and the *patron saints* of modern Rome.*

When we consider the advantages enjoyed by Plato above the philosophers who went before him, can we wonder at the profound wisdom discovered in his works—wisdom such as must imply either sagacity more than human, the aid of inspiration, or the assistance of tradition? His advantages indeed were great, for all the scattered fragments of truth which Thales and Pythagoras had collected, all that Socrates by thought and reflection had acquired, was his before he went to Egypt, where he could not fail to meet with the descendants of those Jews, who, with Jeremiah, were carried from Palestine by Johanan.† This indeed may be collected from his mention of *ancient sayings*, *fables*, and *traditions*, received from the Barbarians, Syrians, and Phœnicians, that is, from the Jews, for both Herodotus and Zenophon inform us that the Jews were called Phœnicians. He confesses that his knowledge of the self-existence of the Deity was derived from the gods themselves; and to prove the immortality of the soul, he appeals to a divine tradition of the ancients, who lived near to the gods. It appears also, from Eusebius, that Plato availed himself of those parts of the scriptures which had been translated into Greek, before the whole was undertaken by the seventy; and for this reason, Numenius the Pythagorean reproached him as the Atticising Moses.* Aristobulus the Jew, with Justin Martyr, and others of the Christian church, confirm this observation, and deliver it as their opinion, that he had seen the sacred scriptures either in the original Hebrew, or at least in a translation; but St. Austin is inclined to think, that he gained all his knowledge merely by conversing with the Jews.†

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* v. Aug. C. D. l. 9, c. 1, 2. 6—13, with the Comment of Lud. Vives.

† Jer. c. 43, v. 5—7.

How striking is the contrast, when the disciples of this school, who were indebted to revelation for their choicest treasures, are compared with those of a proud sect, who had no other guide but reason!

Let us take a transient view of the opinions which prevailed amongst the latter.

Zeno, the father of the stoics, was born at Citium, in the island of Cyprus, and died two hundred and sixty-four years before the birth of Christ. This wise man was sometimes of opinion, that the law of nature is the only God; but at other times he ascribed divinity to the celestial ardour, which he supposed to be an expanse of fire, extending beyond the limits of the air, and surrounding all things. With regard to the cosmogony, he asserted, that before creation God was alone, and so continued till he had coverted the fiery substance into *water*, from which he formed the world, with all the celestial bodies, the sun, the moon and stars, whose motions, said he, being *voluntary*, *prove* them to be gods. He was persuaded that the earth, the air, the sea, are filled with gods and demons, and that these, with the whole visible creation, being dissolved in successive conflagrations, are, at the end of certain periods, swallowed up and lost in God; after which, all distinction of being having been destroyed by fire, a new creation follows. He was equally persuaded, that the sun and all the stars, although gods, yet, like mortals, stand in need of daily aliment, and are nourished; the former, when he goes to rest, by the waters of the Mediterranean Sea; and the latter by vapours, which the sun causes to ascend for them from the surface of the earth. In his opinion, why the sun never wanders further than the solstitial circles, either to the North or to the South, is, lest he should be too distant from his food.*

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* Euseb. Pr. Ev. l. 9, c. 6; l. 11, c. 10; l. 13, c. 12.——Clem. Alex. Strom. l. 1.

† v. Stillingfleet, O. S. b. 3, c. 3, § 13.

Such were the conclusions deduced from arguments arranged in syllogistic forms, by men who were distinguished for the strongest minds. Surely then we must acknowledge, " that the world by wisdom knew " not God; and that the most learned philosophers of Italy and Greece, " being vain in their imaginations, and professing themselves to be wise, " became fools."† When, therefore, we hear these men, with sublimity of thought, explaining some of those truths which had been revealed by Moses; must we not conclude, that they have been indebted for this knowledge to tradition? How far superior to all that we have seen delivered by the sages of Italy and Greece, is the cosmogony of the Roman poet! In this admirable work, the copy has all the air, all the sharp touches of an original production, and the description, in its most essential points, is accurately just—a fair transcript of revelation, accommodated however to the idolatry of the age and country in which he lived. On the formation of man the poet doubts, and leaves the question, between truth and fiction, undecided.

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* D. N. D. l. 2.

† Rom. c. 1, v. 22.

> A creature of a more exalted kind
> Was wanting yet, and then was man design'd:
> Conscious of thought, of more capacious breast,
> For empire form'd, and fit to rule the rest:
> Whether with particles of heavenly fire
> The God of nature did his soul inspire,
> Or earth, but new divided from the sky,
> And pliant, still retain'd th' ætherial energy;
> Which wise Prometheus temper'd into paste,
> And, mix'd with living streams, the *godlike image* cast.
> Thus while the mute creation downward bend
> Their sight, and to their earthy mother tend,
> Man looks aloft, and with erected eyes
> Beholds his own hereditary skies.
> From such rude principles our frame began;
> And *earth* was *metamorphosed into man!*
>
> DRYDEN'S OVID.

After having examined the state of knowledge, respecting the cosmogony, among those nations which, directly or indirectly, had communication with the Jews, and could derive information from their records; let us take a transient view of the opinions which, on this subject, prevailed among the more distant and less enlightened nations, whose whole dependance for information must have been on the vague traditions of their unlettered ancestors. And here I may observe, that among the most remote, this fundamental truth remains, that the universe was both originally formed, and is now governed by one almighty Being, who has existed from eternity.

Even our Scythian ancestors were of this opinion; as appears in the *Voluspa*, an Icelandic poem, in which truth and falsehood are intimately mixed. It thus begins: " In the day-spring of the ages there " was neither sea, nor shore, nor refreshing breezes. There was neither " earth below, nor heaven above, to be distinguished. The whole was " one vast abyss, without herb, and destitute of seeds. The sun had " then no palace; the stars knew not their dwelling-places; the moon " was unacquainted with her power, &c." After a full description of the *chaotic* state, it then proceeds to the production of the earth, with its inhabitants. " The sons of *Bor* slew the giant *Ymer*, and the blood " ran from his wounds in such abundance, that it caused a general " inundation, wherein perished all the giants excepting one, who saved " himself in a bark with all his family. Then a new world was formed. " The sons of *Bor* dragged the body of the giant into the abyss, " and of it made the earth. The sea and rivers proceeded from his " blood, &c." One day as the sons of *Bor* were walking, they found two bits of wood floating on the water; these they took, and of them made a man and woman. To them the eldest of the gods gave life; the second gave them knowledge; from the third they received speech, sight, hearing. This first pair produced the human race.*

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* Mallet's Northern Antiquities, vol. 1, p. 105.

Of the PERSIAN CREED we may venture to pronounce distinctly on the authority of Porphyrius, and of Hyde. The former, quoting from Eubulus, calls Mithras the maker and father of the universe, whose proper image is the sun. The latter, in his inestimable work on the ancient religion of the Persians, describes a race of men who still subsist pure and unmixed among the Mahometans; not only in Persia, but in some parts of India. These people are so tenacious of their ancient customs, that they will not eat with strangers; so careful in preserving the pristine purity of their descent, that they marry only among themselves; and so attached to the religion of their fathers, that no temporal advantages can prevail on them to change it. All their priests, however distant from each other, affirm that they do not worship the sun as God, nor offer up their prayers to any other but to the omnipotent *Creator of the sun* and of the universe; but that in worshipping, they turn toward the sun, as the most perfect of creatures and the throne of God, and that, like the Jews, Greeks and Romans, they have their sacred fires, which, though never worshipped by them, must not be either polluted or extinguished, because they consider fire as an image of the Deity on earth.

They attribute their religion to Abraham, before whose time the inhabitants of Persia had fallen into *Sabaism.* But then it should be rightly understood what *Sabaism* truly is, lest it should be confounded with materialism. For the Sabii, like their ancestors, assert, that God, who dwells in heaven, is the Creator of the universe, but that he is, on account of his majesty and distance, inaccessible to mortals; for which reason they take the angels inhabiting the sun, the planets and the stars, as their mediators: and because these are not always visible, therefore images are made to represent them. From this practice it was, that in Chaldæa, the invisible Creator, ceasing to be the object of worship, escaped from notice, and was finally forgotten; but in Persia he has never been without true worshippers.

Hyde is of opinion, that the Persians have been uniformly misrepresented by the Greeks, and that Zenophon betrays his ignorance when he says, that Cyrus prayed and sacrificed to Jupiter and to the sun; for he neither said, "O paternal Jupiter, and thou sun, and all "ye gods," nor did he offer divine honours to the bright orb of day. The Persians indeed called this luminary *Mihr*, that is, Love, because it cherishes the earth with its all-reviving beams; but they did not regard it as a god. This name, corrupted by the Greeks, was *Mithra*, in the same manner as *Mihridad*, king of Pontus, with them became Mithridates, although, meaning love of justice, it is more properly written, as by Tacitus, *Meherdates*. From ignorance of Persian Theology, Hesychius and Strabo make the same mistakes with Zenophon; the former in saying, "Mithra is the chief god of Persia;" and the latter in asserting, that Mars is their only god. Indeed Herodotus had led the way to these misapprehensions, when he stated of the Persians, "that among "the gods they worshipped the sun alone."

Nothing is more easy than for strangers to make mistakes upon such subjects, and the Greeks may have been rash in their assertions; yet we must candidly confess, that although in Persia, as in Judæa, the Deity may never have been without true worshippers, the vulgar in all countries have been liable to err, and to rest in the symbol, to the neglect of that God who was represented by it. Thus certainly it had been at Jerusalem and in the cities of Judah, when, for this abuse, Josiah put down the idolatrous priests, who burnt incense to Baal, to the sun, to the moon, to the planets, and to all the host of heaven; when he took away the horses which the kings of Judah had given to the sun; when he burnt the chariots of the sun; when he brake in pieces the idols, destroyed the altars, cast out the graven image of the grove, beat down the high places, burnt them at the brook Kedron, stampt them to powder, cut down the groves, and filled their places with the bones of men.*

The account I have given of the Persians is confirmed by Sir W. Jones, who was well qualified to speak upon the subject. According to him, the primeval religion of Persia was a belief, that one supreme God made the world by his power, and governs it by his providence; a pious fear, love, and adoration of him; a reverence for parents and for aged persons; a fraternal affection for the whole human species; and a compassionate tenderness for the brutes.

From what has been here advanced, is it not probable that our judicious Hyde was well warranted in his opinion; and that the progenitors of the Persian tribes were, as supposed by him, instructed in their religious creed by Elam, Shem, and Noah, whom they claim as founders of their race?

We observe vestiges of this religion among the Slavonian hordes prior to the year 988, at which time Vladimir embraced the Christian faith. They had their Jove, or supreme divinity, by them named *Peroun*, precisely as the Creator was called *Peron* by the Welch—a word possibly related to *Puroein* of the Greeks, to *burn*, which agrees with *brennen* of the Teutones, *Brennus* of the Gauls, *brenne* of the Icelandic, and *brinnan* of the Goths; and all these originate in Πυρ—*fire*, as that appears to do in the Hebrew verb which signifies to *burn*. *Peroun* was their god of thunder, and before his image the sacred *fire burnt* incessantly. To him they attributed the formation of the universe, and to him they addressed their prayers in sickness and in extreme distress. But when the Russian monarch became a convert to Christianity, in the ardour of his zeal he treated the image of this god with supreme contempt, for he caused it to be dragged at a horse's tail, to be severely scourged, and to be thrown into the Boristhenes.

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* 2 Kings, c. 23.

Having thus expressed his abhorrence of idolatry, he forbad his subjects to offer up their prayers any longer to the sun, moon, stars, clouds, winds, forests, rivers, mountains, rocks or animals, or to any other being beside the God whom he adored. By this edict we discover the nature and extent of their departure from the faith and practice of their fathers.*

The sacred books of INDOSTAN shew, that, respecting the Creator and creation, the same traditions, although corrupted and disguised by numerous fictions, prevail in the East as in the West. The wise lawgiver of the Hindoos taught them to adore, not the visible material sun, but that divine and incomparably greater Light, which illumines all, delights all, from which all proceed, to which all must return, and which can alone irradiate our intellects.* In their creed *Brame* is this one God supreme, invisible, incomprehensible, who manifests his power by the operation of his Spirit, called *Vishnu.* When this divine energy is exerted in creating, the Deity bears the name of *Brahma;* when destroying, they call him *Siva.* Yet, in the Bhagavat, Brame is represented as saying to Brahma, " Even I was at first, not any other thing, " that which exists unperceived, supreme; afterwards I am that which " is; and he who must remain am I."†

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* Hist. de la Russie, par Levesque, tom. 1, p. 22.

Mr. Maurice has enriched his work with a very interesting abstract of a manuscript, translated from the Purauns, by Halhead, in these words: " Of all objects in the created world, *water* existed first. The " universe was *dark.* In this primeval water did Bhagavat, in a masculine form, repose for the space of a thousand ages; after which, " the intention of creating other beings, for his own wise purposes, " became predominant in the mind of the Supreme. In the first place, " by his will, was produced one flower of the lotus; then the form of " Brahma, who, emerging from the cup of the lotus, looked round " and beheld, from the eyes of his four heads, an immeasurable expanse " of water. In this flower he passed five hundred years in wonder, " perplexity and prayer; after which he produced the four elements, " and the genii which preside over them. From his right side there " issued, by the omnipotence of God, a man of perfect beauty, Swayambhuva Menu, that is, son of the Self-existent; and from his left

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* *v.* Sir W. Jones on the Hindoo Code.

† Asiatic R. v. 1, p. 245.

" side a woman, named Satarupa. Brahma then prayed to Bhagavat
" again to accomplish his purpose in creation, and from the essence of
" Brahma there issued a very small white boar, like the animal called
" *Vara*, which grew to a most enormous bulk. This was the power
" of the Omnipotent embodied, and employed in *separating the earth*
" *from surrounding waters.* *Menu* and *Saturupa* then received Brahma's
" command to *increase* and *multiply*. They had *two* sons and three
" daughters, by whose posterity the whole world was peopled."*

In this maze of folly and of falsehood, we trace such vestiges of wisdom and of truth, as serve to shew, that the several sources, from which these discordant notions are derived, have no communication. The truth came to them by tradition from their well-instructed ancestors; but for the wild conceits of folly, they are wholly indebted to themselves.

That the Arabs had true notions of the Creation, which they received by tradition from Ishmael, their acknowledged progenitor, is evident in the Koran of Mohammed.

The sacred books of the CHINESE, of which copies have been brought to Europe, are transmitted from such remote antiquity, that even in the days of Confusius, who died about four hundred and eighty years before the birth of Christ, all knowledge of their authors had been for ages lost. These convey the most exalted notions of the Deity, who is represented in them as self-existent and eternal, wise, powerful and good, the great unity, the origin of all things, and the universal

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* Maurice, Ind. H. v. 1, p. 410.

Sovereign, whom nothing can resist, and who, whilst he rewards obedience and punishes transgression, is guided equally in both by infinite benevolence.* The purity of this religion, not corrupted by philosophical refinements, not disgraced by superstition, not polluted by idolatry, marks its high descent, and leaves no room to doubt, that it derives its origin from the first patriarchs of the renovated earth. The subsequent fragment of an ode, composed during a time of great mortality, induced by pestilence and famine, may serve at once to confirm this suggestion, and to shew not only the primitive simplicity of their faith, but the sublimity of their conceptions, and the ardour of their devotion.

" Thus then, the Monarch of the skies no longer listens to his " mercy. He desolates the earth by pestilence and famine. Death " meets us at every step, and the mourners, bathed in tears, are multiplied in all our provinces. Oh wrath! Oh vengeance! Heaven " ceases to be directed in its choice of victims: all feel the reiterated " stroke. The eye can distinguish nothing but the convulsions of those " who are in the agonies of death: the ear listens only to their groans.

" It is just: it is right: no mercy for the guilty: let them perish. " But shall the innocent and guilty be involved in one common ruin? " Shall the tender suckling fall from the exhausted breast of the expiring " mother? Let us weep: let us utter sighs: let our groans be heard: " let us hasten to testify our penitence. Oh Father! Father! shall " our guilt, shall our ingratitude restrain the current of thy infinite " goodness and compassion?

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* Ramsay's P. P. 39--44. and Maella's Hist. de la Chine, tom. 11, p. 302.

" But, alas! what is it I see? Blood flows all around me, and " the dagger of the assassin reaches those who have been spared by " famine! Wives, husbands, parents, children, fear and shun each " other: yet, in their haste, they trample on the dead bodies of their " friends, when they are invited to a feast!

" Tremble, impious mortals! tremble; for death enters with the " air you breathe; and those eyes, now full of adultery and incest, " shall soon be closed for ever, &c. &c."

Some pure worshippers still remain in China, and preserve their reverence for the religion of their fathers; whilst many others are *materialists*, and therefore look neither for rewards nor punishments beyond the grave. But the great mass of the people are infected with idolatry, and worship the Indian god Bhudda, under the name of Fo.

From China let us proceed Eastward to AMERICA, and in our progress let us take the learned father Lafitau for our conductor. In his valuable work, stiled, Moeurs des Sauvages Americains compareés aux Moeurs des premiers Temps, he says, " the resemblance is so " striking between them and the most ancient tribes, who wandered " over the plains of Scythia and Thrace, as to leave no doubt of their " being descended from the same stock." He assures us, that all the savages of America believe in the *great Spirit*, whom they consider as the *Creator of all things*. They know him under various names, all expressive either of his attributes or acts.

The Iroquois say, that in the beginning there were six males, but neither earth nor female; yet in heaven there was one woman. After a consultation, one of the men, whose name was The Wolf, mounting on the wings of birds, ascended, and waited at the foot of a tree *till the woman came to draw water*, when he gave her bear's grease to eat, and by his converse seduced her. This being known to the Ruler of the skies, he cast her down from heaven; a turtle received her on its back, on which fish, depositing slime, formed an island, and this grew till it became the habitable earth. This woman had *two sons, who fought till one was slain.* From her descended all the human race.* This account of the turtle, agrees in some measure with what is reported by the Brahmins, that Vishnu changed himself into a turtle to support the falling earth.

As in Europe and Asia the sun was originally thought to be the symbol, or visible image of the Deity, but in process of time became the principal object of religious fear and adoration; so was it also in America: for Lafitau assures us, that not only in Peru, but among all the savage tribes, the sun is worshipped, and the sovereigns regard themselves as not merely his representatives on earth, but his immediate offspring. In this persuasion, they place upon their head a radiant crown, adorned with the most resplendent gems, and so fashioned, as to resemble his diverging beams. The people entertain the same opinion, and therefore pay divine honours to their sovereign. Under this conviction, the Indians of Florida offered in sacrifice all their first-born to their chief, which practice explains a circumstance related in the missionary voyage to Otaheite, where, after a human victim had bled upon the altar, the eye was brought in a dish, and presented as a sacred oblation to the king, who, standing, whilst the priest with great solemnity exposed it to his view, opened his mouth and appeared to swallow it. For in this transaction it seems to have been considered, that the visual orb belonged of right to him, who represented the bright orb of day. But as the procedure of the monarch was symbolical, for he did not actually devour the eye, so may have been originally the apparent object of their worship, whose representative he was; and then the sacrifice, if rightly understood, might have been directed ultimately, not to the material sun, but to the *great Spirit* who is represented by the sun, and who is himself the Creator both of the sun and of the universe.

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* Lafitau, vol. 1, p. 95.

Father Lafitau, who lived many years among the Iroquois, assures us, that they have the same sacrifices, festivals, dances, music, and musical instruments, as the Thracians; that they, with other Indian tribes, have their vestal virgins, sacred fire, consecrated groves, high places, and conical stones, but no temples: that they are divided into *tribes*, with each, a chief, or military leader; and that every village has *three families*, distinguished by the several appellations of the Wolf, the Boar, and the Turtle. He mentions one circumstance respecting the Natches in Louisiana, which has nothing to resemble it among the Iroquois, for they have a temple, and in this the sacred fire is kept constantly burning by *three* logs, which number is held to be so sacred, that they must never be more at a time, nor fewer.

Comparing thus the manners of the American Indians with those of the Scythians, and of the inhabitants of Thrace, he is persuaded, that North America must have been peopled from Tartary, but with regard to the Esquimaux, who are bearded, and whiter than the other tribes, he delivers it as his opinion, that they are descended from the Greenlanders, and came from Europe. This conjecture we may hereafter have occasion to examine, when I proceed to treat of languages, and, by referring to the valuable work of Crantz, we may be convinced, that the Esquimaux, like the other tribes, with their progeny, the modern Greenlanders, originate in Tartary.

Of MEXICO we have a most circumstantial account, which, as being the work of Clavigero, a well-instructed native, is inestimable. By this, it appears that his countrymen worshipped one supreme, invisible God, called *Teotl,* whom they regarded as the Creator of the universe. Subject to him were thirteen great gods, and among these the sun and moon, both produced from heroes, who threw themselves into a great fire in *Teotihuacan.* They had gods also of fire, water, earth, and air, with whom ranked, as one of their principal divinities, a feathered serpent. *Mexitli,* was their god of war, and *Tlazol-Teotl* was the benignant being, whom they invoked for pardon of their sins. These gods were worshipped by images, distributed in forty thousand temples, all endowed with lands, and attended by priests to the number of a million.

Respecting the PERUVIANS we have little information. They have been represented, as confining their worship to the material sun, and it has been asserted by Acosta, that in the whole compass of their language, they had no word for the Supreme, which intimated that they had formed any idea of him as the Creator. But till some enlightened Peruvian shall confirm this account, we may be permitted to believe, with Ramsay, that Pachacamach signifies the supreme Being, and Viracocha, God the Creator.* What little we know of this people leads us to conjecture, that they received religious notions from the Chinese; because, although like the Persians, they had the highest veneration for the sun, their worship was mild, gentle, and humane; because, like the earliest Chinese, they had the *Quipoz;* and because some degree of similarity has been discovered in the languages of China and Peru.

If we have little information respecting the ancient customs of Peru; we have still less with regard to CHILI. Yet, by the information we have recently obtained, it appears probable, that the Chilese may have derived their origin from China. Certain it is that the Araucanians divide their time into years, seasons, months, days, and hours. They have six hours to the day, and as many to the night, like the Chinese, Japanese, and Otaheiteans. It is worthy of remark, that from time immemorial, they have the game of chess.† We may therefore presume, that whatever religious opinions were prevalent in China, attended their colonies in their migrations to the East.

The CARAIBES of the West-Indies, who, in the opinion of Bryan Edwards, derived their origin from Asia, have nearly the same notions of the Deity, as Creator of the universe, with the Chinese, the Hindoos, and the Americans.‡

Of AFRICA we know little: but a modern traveller ventures to assure us, that the Kabobiquas are the only nation among whom can be discovered any idea, however confused, of the existence of a Deity.

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* *v.* Ramsay, v. 2, p. 109.

† Molina's Chili.

‡ Hist. Jamaica, v. 1, p. 50.

Yet he candidly confesses, that he knew nothing of their languages; that to many of them he had no interpreter; and that, from this deficiency, he found it impossible to converse with them.[*] Unfortunately however for this philosopher, the testimony of Mungo Park does not agree with his, and much less does that of the Moravian missionaries, who assert, that not only in the Northern and Southern extremities, but among the intermediate nations, a belief in one supreme Divinity universally prevails. And with regard to the negroes, whether collected from the coast of Guinea, or from the interior of the country, we know for certain, that, although subject to the darkest and most detestable superstition, they entertain a confused notion of one great Spirit, the Author and Governor of the visible creation.

The ABYSSINIANS, as we are informed by Bruce, are the same people with the Egyptians, but in government, laws and customs, agree exactly with the Persians.[†] Consequently, whatever notions respecting creation and a Deity have been preserved by the last-mentioned people, must have been, from remote antiquity, transmitted to the former. The state of knowledge among the Persians we have already seen; and as to the Egyptians, it is agreed both by the Christian fathers and by the most learned pagans; by Cyprian, Lactantius, Origen, and Justin Martyr on the one hand; and by Plutarch, Iamblicus, and Porphyry on the other; that the wise men among them, although gross idolaters, held one supreme, self-existent Deity; immutable, incomprehensible, invisible, the first principle of all things. These sublime ideas the Egyptian philosophers concealed under the veil of allegories. For Plutarch informs us, that their theology had two meanings, the one symbolical and sacred; the other literal and profane, suited to the comprehension of the vulgar: and that the figures of animals in their temples were designed to represent the attributes of God. He particularly states, that the crocodile was an appropriate symbol of the Deity, because this animal hid in the water, sees all things and is itself unseen. Agreeably to these notions, Iamblicus, a disciple of Porphyry, tells us that *Eicton*, the supreme divinity of Egypt, existed before all things, in solitary unity, the fountain of intellect, incorporeal and invisible; and that he is to be adored as ruling over all, and containing all things in himself. This philosopher explains the reason why the Deity was represented as seated on the lotos, an aquatic plant; which was simply this, that, as the hieroglyphic for matter was mud and *water;* by this symbolic representation they expressed the transcendant excellence of the Deity, and his dominion over the material world.* They believed that the world had a beginning; and certain it is, if we may give credit to Iamblicus, that the priests, both in their doctrines and in their sacred offices, exhorted men to ascend above matter, to an incorporeal Deity, the Maker of the universe.†

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[*] Vaillant, vol. 3, p. 96.

[†] Vol. 3.

From the inscription on the temple of Neith—" I am all that was, " is, and shall be, and my veil has no man removed;" compared with what has been stated respecting the cosmological notions of the Egyptians, we may collect, that they considered the visible creation as at once an emanation from the Deity, and the veil under which he is concealed. Among the Greeks this opinion of his being all and in all, gave rise to their name and description of their sylvan god. It must be confessed that *Pan* is represented clad in a leopard's skin, rough in his appearance, and lascivious in his disposition. From the waist upwards they gave him the human form with youth and beauty; but in his lower extremities he was perfectly a goat.* In all this we have only the developement of a complex idea, a symbolical representation of creation, and a descriptive image of Him who is the genuine *Pan*, that is, *all in all.* Such seems to be the obvious meaning of this fantastic picture: but if we wish for authority to confirm our conjecture, that of *Phornutus* is at hand, who says, that the lower extremities represent the earth, rough, yet prolific; whilst the head is the proper emblem of intellect, disposing all things for the best; and the spotted garment is an image, not only of the starry firmament, but of the material world, which is to be admired for the number, variety and beauty of its productions. As to the circumstance of his being a sylvan deity, this has been explained by Macrobius, who wrote his Saturnalia towards the close of the fourth century: for, speaking of the Arcadian Pan, he tells us that they call him the supreme lord of *Hyle*, not as presiding over *woods*, and dwelling in the sylvan shade, but as having absolute dominion over *matter* and the material world. In fact, this distinction turns upon an equivocal expression in the Greek, which means indifferently either *matter* in general, or a *wood.*

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* Ramsay, P. P. II. 53—59. Cudworth, I. S. I. c. 4, § 18.

† Stillingfleet, O. S. b. 3, c. 2, § 2.

Beside the god already noticed, the Egyptians are reported by Eusebius to have had another, named *Cneph*, whom they regarded as the

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* *v.* Spence's Polymetis.

Maker of the universe. Under this notion his image in the human form, represents the mundane egg proceeding from his mouth, an apt hieroglyphic of creation; not only because the egg conceals within itself the principle of life, but because, when the Almighty was to give existence to our world, he *spake*, and it was made; he commanded, and it stood fast. The report of Eusebius perfectly agrees with the information we receive from Plutarch, in his treatise on Isis and Osiris, who says, "The "inhabitants of Thebais contributed nothing towards the support of the "sacred animals, because they would acknowledge no mortal god, nor "any other deity than him whom they call *Cneph*, he being ungene-"rated and immortal."

What has been here delivered, when compared with the doctrine and opinions of Pythagoras, which, as we have seen, he acquired in Egypt, may suffice to shew, that the Egyptians, although addicted to polytheism, superstition and idolatry, had yet, respecting the creation, some glimmerings of truth, which must have been derived by tradition from their progenitors.

From all that has been said, we may infer that such concurring evidence—the evidence of nations which from remote antiquity have had little communication and no connection with each other, is sufficient to demonstrate, that their traditions have had one common origin, and no other can be imagined than that, which the advocates for revelation have discovered in the Mosaic account of the creation.

Independently, however, of the argument deduced from universal tradition, the principal circumstances in the Mosaic account of the creation are confirmed by modern observations and discoveries. For, in the first place, the earth must have acquired its oblate spheroidical form by revolving round its own axis whilst in a fluid state.—Sir Isaac Newton was the first to affirm, that the axis of every planet is less than the diameter drawn perpendicular to it. This, with respect to our globe, both the Spanish and the French philosophers have verified, by measuring a degree of the meridian near the equator; and this Dr. Herschel has observed in the planet Mars.

The fact itself being incontrovertible, it has been imagined by some philosophers, who are no friends to revelation, that the fluidity in question was occasioned, not by water, but by fire, and that therefore the Mosaic account of the cosmogony is false.

The most eminent of these, taking for granted that the sun is a ball of fire, conceited that all the planets of our system were thrown out of it by the shock of some impinging comet, and that our earth was originally only liquid glass covered with water. But unfortunately for his reputation as a philosopher, he did not consider, that, according to the known laws of motion, and of the planetary system, no comet, however elliptical may be its orbit, can impinge against the sun about which it is revolving; nor, supposing the planets to have been thrown out of the sun, like scoriæ from the blacksmith's anvil, could they have revolved, as they do, about one common centre.

But, in the second place, from the appearance of our rocks, we may venture to infer, that such of them as are crystallized were in a state of solution; not of fusion. It is allowed by chemists, that whatever has been fused is fusible; but neither granite, nor, more especially, quartz, which is a principal component part of granite, nor silex, in whatever situation or form it may appear, is fusible without the assistance of an alkali. And it is well known, not only that quartz crystals retain in their composition their water of crystallization, but that sometimes they inclose a drop of water, which must have been separated at the time of crystallizing. The other component part of granite, called field spar, or *feld spat* by the Germans, loses from a quarter to nearly one half its weight by evaporation in the fire. Besides, granite recently formed in the moist way has frequently been found, but no instance can be produced of its formation by fire.

That the crystallization in question took place in water would even, without the argument above stated, be rendered probable, because the inferior crystals, both of field spar and quartz, are comparatively small; whilst the superior, or those which are supposed to have subsided last, having free scope for motion, are much larger, as may be seen on the lofty summits of the Alps. I am indebted for this observation to the Count de Bournon, a naturalist, who, previous to the French revolution, having devoted his life and fortune to the study of mineralogy and geology, with indefatigable industry searched repeatedly the Alps, Apennines, and Pyrenees, and who, under the most severe privations, still gives up his time and attention to these pursuits. His observation is confirmed by every fact which has been brought forward by Spallanzani, by Verner, by De Luc, and by Saussure.

As the granite rocks seem to manifest that their formation was aqueous; so do the superincumbent strata of porphyry and gneiss; of siliceous, micaceous, and argillaceous schist; and beyond a question, the calcareous mountains, as will be demonstrated in the progress of my work, were formed by subsidence in water.

With what amazement then must the naturalist, whose patient step has traversed different countries, to inspect, as well the deepest mines as the most elevated peaks; with what amazement must he view philosophers, who gravely tell him, that all our strata, siliceous, argillaceous, and calcareous, have been consolidated by simple fusion! But I forbear at present making observations on their extravagant hypothesis, because the subject will be resumed when I proceed to treat of the universal Deluge.

Thus whilst directly engaged in the establishment of one truth, we have indirectly brought to light others, of no less importance to the credibility of the Jewish history, as contained in the Pentateuch. For, in the first place, from the traditions to which I have referred, we have the strongest reason to believe, that all the nations of the earth are descended from one family; a fact which, when we shall have examined their languages, will be abundantly confirmed. But, in the second place, we have clearly seen, that whilst the pure worship of Jehovah was preserved in one sequestered spot, all the surrounding nations, devoted to polytheism, as declared by Moses, were enslaved by the most detestable vices, the most execrable superstition, and the most absurd idolatry.

How inestimable then must we consider the authentic records, which from generation to generation have been preserved in the sanctuary! Without them, the whole human race would have been involved in midnight darkness. Many, in this age of reason, pour contempt on revelation. But what did our ancestors derive from unassisted reason? What the Egyptians, Greeks, and Romans, when this lamp burnt brightest? The first idolatry of rude nations was the worship of the celestial orbs, or rather of the deities who were supposed to take up their residence in them. This soon degenerated, and the luminaries themselves were worshipped as gods. The more civilized and learned nations improved on this idolatry, and not only raised to the celestial hierarchy their heroes, but erected temples to the vilest passions of the human race. "Professing themselves to be wise, they became fools; "and, having lost sight of a Creator, changed the glory of the uncor- "ruptible God into an image made like to corruptible man, and to "birds, and four-footed beasts, and creeping things."

Such was the triumph of reason unassisted by revelation!

SUBJECT II.

OF THE SEPTENARY DIVISION OF TIME, AND THE SABBATH.

THE presumption that all nations are derived, as recorded by Moses, from one common ancestor, is confirmed by the prevalence of the septenary division of time in distant countries, and by the reverence in which the seventh day has been held from the most remote antiquity. This division and this reverence have been traced in Persia, Indostan, Tartary, Japan, Peru, and Chili, as well as in every part of Europe; and, if we may credit M. de Gebelin, they existed formerly in China, where the seventh was called the great day.*

Yet no physical cause can be assigned why these distinctions should have obtained; why attention should have been paid to one day more than to the rest; or why this preference should have been given to the seventh day. The consequence naturally flowing from these premises appears to be, that such attention originated in a positive command. This precisely is what I shall immediately proceed to state, and then the presumption will be strengthened, that the custom in question was derived by tradition from the family, which gave birth to all the rest.

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* Monde prim. tom. 4.

The Jewish historian has informed us, that when the Almighty had brought his works of creation to perfection, he sanctified the seventh day; and from this declaration, compared with the subsequent conduct of the faithful, even before the promulgation of a special law upon that subject, as recorded in the books of Genesis and Exodus, we may collect, that, from the foundation of the world, this day was appointed as a day of rest, in which, by sacred solemnities, the human race might constantly preserve the knowledge of their Creator. And it is probable, that as long as men continued to revere the sabbath, so long they retained this knowledge; but that, neglecting the religious duties of the day, they finally apostatized from God.

That the septenary division of time, with the planetary distinction of days, goes back to the most remote antiquity, is not only to be learnt from Hesiod, Homer, and Herodotus; but may be demonstrated by its present existence in every quarter of the globe, among savage hordes as well as in the most enlightened nations; because whatever customs are universal, and yet not founded in nature, must be traced backwards to common ancestry, and to the first ages of the world.

The Gothic days of the week, and those of the Hindoos, are not only dedicated to the same luminaries, but revolve in the same order.

These, according to Sir W. Jones, are, 1, Ravè, the sun; 2, Soma, the moon; 3, Mangala, Tuisco; 4, Bhudda, Woden; 5, Urihaspati, Thor; 6, Sucra, Freya; 7, Sani, Sater. Indeed all Orientalists agree, that in the most ancient Sanscrit books, the days of the week are named from the same planets, to which they were assigned by the Greeks and Romans. Let us, however, see what has been advanced by various writers on the subject.

Dion Cassius, speaking of the Jewish sabbath by the appellation of Saturn's day, delivers it as his opinion, that the practice of denominating days from the seven *planets;* that is, for thus he explains himself, from the *sun*, moon, Mars, Mercury, Jupiter, Venus, and Saturn, was derived from Egypt, and from thence diffused among all nations. This practice, however, he considered as of late invention. But that he was mistaken in this point appears from multiplied authorities, for Justin Martyr, who wrote long before Dion Cassius, says distinctly to the Emperor, "We assemble on Sunday, because it was the day on "which God put an end to darkness, and from chaos formed the world. "On this day also Jesus Christ our *Saviour* arose triumphant from the "dead. For the day *preceding* Saturn's day they crucified him, and "on Sunday he appeared to his disciples."[*] Had Dion Cassius been sufficiently conversant with the works of the most ancient poets, he might have recollected, that Homer represented Saturn as presiding over the seventh day.

’Αλλ ‘ότ ’άρ’ ἕβδομον ἦμαρ ’επὶ Ζεὺς ϑῆκε Κρονίων.[†]

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[*] Apol. Sub. finem.

[†] Od. 12.

That the religious observance of this day is equally ancient with the septenary division of time, is rendered probable by their having been unitedly diffused among the scattered nations of the earth. The expression of the seventh, a sacred day—ἑβδόμη ἱερὸν ἦμαρ—was familiar to the pen of Hesiod, the most venerable of the Grecian poets. And Tertullian, in his Apology, reminds the Gentiles of their sabbaths or festivals observed on Saturdays. But, prior to this, Josephus ventured to affirm, "There is no city, whether Grecian or Barbarian, there is "no nation, which does not rest on the seventh day."* This affirmation perfectly agrees with what had been stated many years before by Philo Judæus; that the seventh day was a festival, not to one city or one country, but to all; and he therefore calls it the *universal festival.*

Such testimonies are sufficient of themselves to prove the universality of the practice in question; but they do not stand alone, nor are we constrained to seek evidence merely from the friends of revelation: for we may appeal to Lucian, who flourished in the second century, and who informs us, in his Pseudologista, that children at school were exempted from study on the seventh day. This day Suetonius calls a *sabbath. Diogenes grammaticus disputare* sabbatis *Rhodi solitus, venientem, ut se extra ordinem audiret, non admiserat; ac per servulum suum in* septimum *diem distulerat.*† The same notion of sanctity, which appears in Hesiod, and in our sacred code, is conveyed by Tibullus, a poet of the Augustan age, when he speaks of the day sacred to Saturn. *Aut omnia dira Saturni sacrâ me tenuisse die.*

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* Contra Ap. l. 2, c. 39.

† Sueton. l. 3, c. 32.

Vestiges of the reverence in which the seventh day was held, are to be observed in nations which have had no direct communication with either the Christians or the Jews; but no where do we more distinctly trace them than among the tribes which compose the Birman empire: for Mr. Symes informs us, that their month is divided into four weeks, of seven days each; and thus the eighth day of the increasing moon, the full moon, the eighth day of the decreasing moon, with the last day of the moon, are religiously observed as sacred festivals, in which no public business is transacted, mercantile dealings are suspended, and handicraft is forbidden.* Even among wandering hordes of Tartary we find attention paid to the seventh day above the rest; and the Tchonvaches in particular are noticed by Professor Pallas, for their observation of the sabbath.†

From all that I have said on this subject we may venture to conclude, that the Almighty from the beginning sanctified the seventh day; and that in this instance also, as in the preceding, the veracity of Moses stands unimpeached

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* Embassy to Ava, vol. 2, p. 398

† Voyages, tom. 1, p. 142.

SUBJECT III.

OF THE STATE OF INNOCENCE, AND THE FALL OF MAN.

THE fall of man from a state of innocence, as related by Moses, is such a memorable event, that we may reasonably expect to meet with traces of it, more or less distinct, among all nations. In this expectation we are not deceived. Let us then begin our investigation with the Bœotian bard.

Hesiod introduces Prometheus stealing fire from heaven, and Vulcan, by the command of Jove, forming out of the earth a graceful virgin, the very image of an immortal goddess, whom her nymphs, the Horæ, crowned immediately with vernal flowers. This was Pandora, the gift of Jupiter to the incautious brother of Prometheus. But no sooner had she gained admission to his house, than, to indulge a criminal curiosity, she removed the cover of a box, and let loose upon mankind a host of evils, disease, pain, poverty, and discord, attended by war, famine, pestilence, old age, and death. Then follows an account of the golden, silver, and brazen ages; the age of heroes, who distinguished themselves at Troy; and lastly, the iron age.

In the golden age, during which Saturn ruled the earth, men enjoyed perfect felicity, free from toil, void of care, exempted from disease, and strangers to the ravages of time; till death, like soft slumbers, closed their eye-lids, and transported them to superior regions, where they became associates of the gods.*

This golden age is described by *Plato*, in a manner which, independantly of his confession, proves him to have derived his information, not from written records, but from traditional reports. His mansion of primeval bliss was not in this dark, diminished and deformed, this corrupted globe, but in a pure, etherial and lucid orb of unlimited extent, where men breathed, not air, but light, drank nectar, and partook of fruits spontaneously produced. There inclement seasons were unknown, raiment not yet invented, and nakedness produced no distress. When weary, the inhabitants reclined to sleep on soft herbage, which received the influence of one eternal spring. In these delightful regions no stormy winds interrupted their calm repose; no evil passion disturbed their serenity of soul; and reason, guided by benevolence, bore an universal sway. Whilst this state continued, man conversed freely with those animals, which, now wild, avoid his presence, and fly at his approach.

Plato confesses that he gained this information from the Phœnicians, who received it from their ancestors.

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* Hesiod, Works and Days, 47.

Virgil was no stranger to a golden age; and *Seneca* well described the peaceful state whilst Saturn reigned. But of all the representations, that which we find in Ovid is the most beautiful, and, allowing for poetic imagery, is accurately just.

> The golden age was first; when man, yet new,
> No rule but uncorrupted reason knew,
> And with a native bent did good pursue.
> Unforced by punishment, unawed by fear,
> His words were simple, and his soul sincere.
> Needless was written law where none opprest:
> The law of man was written in his breast.
> No suppliant crouds before the judge appear'd;
> No court erected yet, nor cause was heard;
> But all was safe, for conscience was their guard: &c.
>
> DRYDEN'S TRANSLATION OF OVID.

Such notions of the felicity enjoyed by man in a state of innocence were not confined to Italy and Greece, but have been discovered equally among the Persians, Indians, and Chinese. The latter have preserved, in one of their sacred books, these short sentences: "We possessed "fertile fields: a woman robbed us of them. We were sovereigns: "a woman made us slaves."*

The Brahmins say, that in the beginning of the world, plenty was every where diffused, and milk, with wine and honey, flowed from fountains.* Similar images were used by the Persian magi to convey a notion of primeval happiness.

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* Duhalde, vol. 2. p. 313.

The loss of our felicity was attributed by most philosophers to the envy of malignant spirits; and Plato was persuaded, that the author of physical and moral evil is a self-existent, independant being, who opposes the benevolent designs of a co-existent deity, from whom all good proceeds. Such were Oromasdes and Ariman of the Persians; such Brahma and Seeva of the Hindoos; and similar to these, Osiris and Typho of the Egyptians.

But although most philsophers attributed the origin of evil to a malignant spirit, some few, with Pythagoras, blamed only the essential malignity of matter. Even the stoics, who derived the universe from one independant and eternal God, yet, unable to discover any other source for evil, conceived that matter, although neither good nor evil in itself, was accidentally its cause. The latter Platonists, having more information than their predecessors, attribute the dire effect in question to mental malignity, and the abuse of free agency in man. Hierocles, who presided in the Alexandrian school about three hundred years after the birth of Christ, considered the human race as intermediate between those beings who always contemplate the Deity, and those which never turn their attention towards God. Agreeably to this opinion, he taught his disciples, that by using or rejecting reason they might exalt themselves to the former, or sink down to the level of the latter; and thus resemble either brutes, or God. This philosopher asserted, with Pythagoras, that all the sufferings of mankind are the consequence of their own volitions: a sentiment well expressed by Juvenal—

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* Strabo, l. 15; and the Ramayuna, b. 1, sect. 5, 6.

Fortune was never worshipp'd by the wise,
But, set aloft by fools, usurps the skies.

Te facimus fortuna Deam cœloque locamus.[*]

The present perverseness of the human will, and the dominion acquired by passion over reason, have been the topic of universal lamentation; for it was not Araspas only who complained of this, when, to apologize for his inconsistency of conduct, he affirmed, that he had two souls; one urging him to good, and the other enticing him to evil. This generous youth conceited, that when the good soul presided, commendable actions were performed; but that, when the evil soul assumed command, it led to every thing most treacherous and base.[†] Others among the ancients were persuaded, as Socrates seems to have been, that good and evil demons influence the conduct of mankind; and from this notion the genii of the Arabs may be derived. But the Roman poet points more directly than Socrates to the two contending powers in the human soul:

Discretion this; affection that persuades:
I see the right, and I approve it too;
Condemn the wrong, and yet the wrong pursue.[‡]

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[*] Sat. 10. 366.

[†] Zenoph. C. P. l. 6.

[‡] Ovid, l. 4. 19.

Plato makes nearer approaches to the truth than any of the Grecian sages. He represents the souls of men as in a lapsed condition; but then he supposes, that they are suffering correction upon earth for offences individually committed during their pre-existence in superior regions, the pure abode of virtue and felicity. Even the circumstances attendant on the Fall, with its baleful influence on the happiness and morals of mankind, are darkly and ænigmatically described by him; for, in his relation of the fact, Porus, being drunk with nectar, went into the garden of Jupiter, where he fell asleep, and whilst he was in this condition, Penia crept into his bosom, and conceived by him, for which offence he was cast out by the father of the gods.

The doctrine of Empedocles was somewhat similar to this, but more agreeable to truth. He taught his disciples, that souls are here in a lapsed state, strangers, wanderers, and fugitives from God; but that, if men are just and holy, they will be happy in life, and happier after death to all eternity. Such is the information to be collected from the writings of philosophers.

But, in addition to these traditional reports, men appear, from the most remote antiquity, to have established memorials of these dire events in the celestial sphere, to which they transferred rude images of the principal personages concerned in them, as may be observed in the zodiacal signs and the attendant constellations. Thus when the Virgin sinks, Serpentarius and the malignant Scorpion rise to bring forward the gloomy, cold, unfruitful months of winter. But when Aries rises to restore both light and life to the dark and torpid earth, he is attended by Perseus, with his flaming sword in one hand, and the head of Medusa in the other.

M. Dupuis imagines, that these constellations gave birth to the historical relation of the Fall: but it is more reasonable to conclude, that they were contrived, before the invention of letters, to keep up at once the remembrance of the Fall, and the hope of a deliverer.

In the Farnese globe, and in the ancient spheres, the balance was represented as supported by the claws of the scorpion; but on the apotheosis of Augustus, the Scorpion drew back his claws, and made room for that emperor to assume the balance of the world.* Whilst he yet lived, his poet had assigned him this abode; and the same compliment, then most elegantly paid to him by Virgil, was repeated, but perhaps ironically, by Lucan to Nero;† by Statius to Domitian;‡ and by Valerius Flaccus to Vespasian.|| The expedient, then resorted to for the honour of Augustus, was conformable to ancient usage, and the constellations were in this case suited to the supposed event: but in China they are perfectly historical, and have appropriate names, which remind succeeding generations of customs and events in which their ancestors were interested. To invert this order is not agreeable to the practice of mankind. Keeping this observation constantly in view, the laborious work of M. Dupuis§ may be perused with equal instruction and amusement.

I say nothing of his atheistical opinions, nor of his blasphemies and most absurd suggestion, that Moses and the prophets, that Christ and his apostles, taught only the worship of the sun. This notion is too ridiculous to need a refutation. We cannot but admire his patience; yet, in all his investigations, he resembles *Cacus*, when he stole the oxen of Hercules, and, to avoid detection, drew them backwards to his den. He has displayed indefatigable industry; but whoever, not suspecting guile, shall tread in his footsteps, will be led astray in a direction exactly opposite to truth, and will never discover the deceiver in his dark and detestable abode.

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* Virgil, Georg. I. 32—35. † Pharsal. I. 44—59. ‡ Theb. I. 31. || Arg. I. 20.

§ Origine de tous les Cultes.

No man, who is not blinded by passion or prejudice, can mistake the intention of celestial symbols, which, among other purposes, were undoubtedly designed to direct the attention towards things conceived to be represented by them, and thereby not only to record transactions past, but to convey the most sublime instruction to mankind. Thus, for instance, when we read, "The Lord God is a *sun* and shield; the "Lord will give grace and glory;" we are taught by a sensible image, and that image the most magnificent in nature, that Jehovah is the source of light and life, infinite in wisdom, beneficence and power.

SUBJECT IV.

OF SACRIFICE.

IN contemplating the religious rites and ceremonies of mankind, with what astonishment must philosophy behold the superstitious multitude presenting their oblations, and binding their victims to the altar, as if their divinities stood in need of daily sustenance, or as if their protection were to be purchased by blood! From what principles in nature can this practice be accounted for? How was it ever suggested to the mind, that the blood of bulls and of goats could take away sin? When Guilt was solicitous to know the terms of acceptance with the Deity, and when the trembling votary inquired, "Wherewith shall I come before the "Lord, and bow myself before the high God? Will the Lord be pleased "with thousands of rams, or with ten thousands of rivers of oil? Shall "I give my first-born for my transgression; the fruit of my body for the "sin of my soul?" To such a question, would not the common understanding of mankind have returned for answer, "He hath shewed thee,

" O man, what is good; and what doth the Lord require of thee but
" to do justly, to love mercy, and to walk humbly with thy God?"

Since then, in all ages, not only the most rude, but the most polished nations, have agreed to offer sacrifice; this universal practice, if not suggested by human reason, as it certainly was not, must have originated in a positive command, and, being sanctioned by the authority of Heaven, must have been transmitted by one generation to another, in succession from their first progenitors: for men would never have sacrificed to idols, had they not previously been taught to prostrate themselves before the altars of Jehovah.

In the writings of Moses no positive injunction appears for the first oblations of the human race; but it is simply said, that in process of time, Cain, who was a tiller of the ground, brought, of his first fruits, an offering to the Lord; and Abel, who was a shepherd, brought the firstlings of his flock; yet, as it is stated that the Lord had respect to Abel's offering—an offering not suggested by reason, it may be presumed, that he acted in obedience to a divine command. The next altar we discover was erected by Noah, when he came forth from the ark, and offered of every clean beast burnt offerings to the Lord. These likewise received tokens of acceptance.

From this time to the call of Abraham few events are left upon record, nor is any mention made of sacrifices; but of him it is related, that he erected altars to the Lord in a grove at Sichem, on a mountain to the East of Bethel, and on Mount Moriah, to which he was particularly directed, and on which, in process of time, Solomon was to build the temple of Jerusalem.

The offspring of Abraham, as was predicted, followed his example, worshipped his God, and presented their oblations on his altars: yet, whilst his posterity remained in Egypt, it is no where related, that they offered sacrifice, and Moses himself assigns the reason why, at the time of their departure, they could not with safety do it: " Shall we," said he to Pharaoh, " shall we sacrifice the abomination of the Egyptians " before their eyes, and will they not stone us?"

Yet the probability is, that a practice, derived from their progenitors, was not wholly lost; for no sooner had they quitted Egypt, than on their defeating Amalek in Rephidim, Moses, in token of gratitude, built an altar to the Lord. Indeed from the first entrance of Israel into Egypt, till the time when the shepherd kings were driven out, heifers, goats and sheep, might have been offered in sacrifice with safety.* However no sooner did the Israelites become an independant people, than altars were, by divine appointment, erected to the Lord, before which, not only occasional, but annual, nay, even daily, victims bled.

The design of this institution will be considered in its proper place. What I am at present solicitous to prove is simply this, that sacrifices were of divine original, sanctioned by Heaven in the first ages of the world, and, by Moses, strictly enjoined to God's peculiar people. The intention of this institution was however frustrated, and in process of time forgotten, by the scattered nations of the earth. Nay, even the guardians themselves of these sacred rites soon perverted them to the service of their idols; for within six weeks after the law had been delivered on Mount Sinai, they made a molten calf and sacrificed to it; "they sat down to eat and to drink before it, and they rose up to play. Nay so strong was their propensity to idolatry, that no admonitions, no chastisements, were sufficient to check its progress, till the whole nation was carried captive to Babylon. Even Solomon, influenced by his wives and concubines, built an high place for Chemossh, the abomination of Moab; and for Moloch, the abomination of the children of Ammon.* No wonder then that Jeroboam readily persuaded the ten revolted tribes to offer their sacrifices on the altars erected to his golden calves in Dan and Bethel.

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* v. Bruce's Abyssinia.

When mankind lost sight of a beneficent Creator, the God of purity, and consecrated altars to the sun, the moon, the stars, to demons, and to hero gods, under the names of Moloch, Ashtaroth, and Baalim; these objects of their worship led them to the most horrid acts of cruelty, and to every species of obscenity. Respecting the latter I shall be silent, "for it is a shame even to speak of those things which were done of "them, not in secret, but in the face of day;" and of the former it may be sufficient to say, that "even their sons and their daughters they "burnt in the fire to their gods," more especially in seasons of distress. Such was the conduct of the King of Moab; for when he was besieged in his capital, and expected he should fall into the hands of his enemies, he took his eldest son, who should have reigned in his stead, and offered him for a burnt-offering on the wall.†

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* For the nature of High Places see Mr. King's Munimenta Antiqua, on 1 Kings, c. 11, v. 7.

† 2 Kings, c. 3, v. 27.

With these facts, thus related from the scriptures, all accounts, ancient and modern, exactly correspond. Homer, who, it must be recollected, wrote more than nine hundred years before the Christian era, although he describes chiefly the common sacrifice of quadrupeds, yet gives one account of human victims. But, in succeeding generations, when it was conceived that one great and most malignant spirit was the proper object of their fear, or that subordinate provincial gods, equally malignant, *nesciaque humanis precibus mansuescere corda,** disposed of all things in our world; men bound their own species to the altar, and in circumstances of national distress presented such as they valued most, either their children or themselves. Herodotus informs us, that when the army of Xerxes came to the Strymon, the Magi offered a sacrifice of white horses to that river. On his arrival at the Scamander, the king ascended the citadel of Priam, and having surveyed it, he ordered a thousand oxen to be sacrificed to the Trojan Minerva. But on other occasions he chose human victims, for we are informed that, when, having passed the Strymon, he reached the nine ways, he buried alive nine young men, and as many virgins, natives of the country. In this he followed the example of his wife, for she commanded fourteen Persian children, of illustrious birth, to be offered in that manner to the deity, who reigns beneath the earth. Thus in the infancy of Rome, we see Curtius, for the salvation of his country, devoting himself to the infernal gods, when, as it appears, an earthquake had occasioned a deep and extensive chasm in the forum; and the augurs had declared, that the portentous opening would never close, 'till what contributed most to the strength and power of the Romans should be cast into it; but that by such a sacrifice they would obtain immortality for their republic. When all men were at a loss how to understand this oracle, M. Curtius, armed as for battle, presented himself in the forum, and explained it thus—"What is "more valuable to Rome than her courage and her arms?" So saying, he urged forward his impetuous steed, and buried himself in the abyss.* His grateful countrymen admired his fortitude, and attributed the increasing splendour of their state to the sacrifice he made. Animated by this example, Decius, in the war between Rome and Latium, having solemnly offered himself as an expiatory sacrifice, rushed single into the thickest ranks of the astonished Latins, that by his death he might appease the anger of the gods, transfer their indignation to the enemy, and secure the victory to Rome. Conspectus ab utroque acie aliquanto Augustior humano visu, sicut Cælo missus piaculum omnis deorum iræ, qui pestem ab suis aversam in hostes ferret.†

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* Virgil, Geor. IV. 470.

Here we see distinctly marked the notion of vicarious suffering, and the opinion, that the punishment of guilt may be transferred from the guilty to the innocent. The gods call for sacrifice: the victim bleeds: atonement is made: and the wrath of the infernal powers falls in its full force upon the enemy.—Thus whilst Themistocles at Salamine was offering sacrifice, three captives, the sons of Sandauce, and nephews to Xerxes, all distinguished for their beauty, elegantly dressed, and decked, as became their birth, with ornaments of gold, being brought on board his galley; the augur Euphrantides observing at the very instant a bright flame ascending from the altar, whilst one was sneezing on the right, which he regarded as a propitious omen; he seized the hand of Themistocles, and commanded that they should all be sacrificed to Bacchus, (*ωμηστη Διονυσω*—cruel and relentless Bacchus! Homer has the same expression) predicting, on this condition, safety and conquest to the Greeks. Immediately the multitude with united voices called on the god, led the captive princes to the altar, and compelled Themistocles to sacrifice them.*

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* Livy l. 7. c. 6.

† Livy. VIII. 10.

So when Æneas was to perform the last kind office for his friend Pallas, he sacrificed (beside numerous oxen, sheep, and swine) eight captives to the infernal gods.† In this he followed the example of Achilles, who had caused twelve Trojans, of high birth, to bleed by the sacerdotal knife, over the ashes of his friend Patroclus.

A hundred feet in length, a hundred wide,
The glowing structure spreads on every side;
High on the top the manly corse they lay,
And well-fed sheep and sable oxen slay;
Achilles covered with their fat the dead,
And the piled victims round the body spread:
Then jars of honey, and of fragrant oil
Suspends around, low bending o'er the pile.
Four sprightly coursers, with a deadly groan
Pour forth their lives, and on the pyre are thrown.
Of nine large dogs, domestic at his board
Fell two, selected to attend their lord:

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* Plutarch I. 262.

† Æneid l. 10. 517. 11. 197.

The last of all, and horrible to tell,
Sad sacrifice! twelve Trojan captives fell;
On these the rage of fire victorious preys,
Involves and joins them in one common blaze.
Smeared with the bloody rites, he stands on high,
And calls the spirit with a dreadful cry,
All hail, Patroclus! let thy vengeful ghost
Hear and exult on Pluto's dreary coast.

POPE'S HOMER'S IL.

How much was it to be lamented, that even civilized nations should forget the intention for which sacrifices were originally instituted! The bad effects, however, would not have been either so extensive or so great, had they not wholly lost the knowledge of Jehovah, and taken as the object of their fear that evil and apostate spirit, whose name, with the utmost propriety, is called Apollyon the Destroyer,* and whose worship has been universally diffused at different periods among all the nations of the earth.

The practice of shedding human blood before the altars of their gods was not peculiar to the *Trojans* and the *Greeks;* the *Romans* followed their example. In the first ages of their republic, they sacrificed children to the goddess Mania; in later periods numerous gladiators bled at the tombs of the Patricians, to appease the manes of the deceased. And it is particularly noticed of Augustus, that after the taking of *Perusia* he sacrificed, on the ides of March, three hundred senators and knights to the divinity of Julius Cæsar.†

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* Rev. 9. 11.

† Sueton in Vit. Oct. § 15. and *v.* Sanct. Inst. Div. l. 1. c. 21.

The *Carthaginians*, as Diodorus Siculus informs us, bound themselves by a solemn vow to Chronus, that they would sacrifice to him children selected from the offspring of their nobles; but in process of time they substituted for these the children of their slaves, which practice they continued till being defeated by Agathocles, tyrant of Sicily; and attributing their disgrace to the anger of the god, they offered two hundred children, taken from the most distinguished families in Carthage, beside which, three hundred citizens presented themselves, that by their voluntary death they might render the deity propitious to their country. The mode of sacrificing these children was horrid in the extreme, for they were cast into the arms of a brazen statue, and from thence dropped into a furnace, as was practised among the first inhabitants of Latium. It was probably in this manner the Ammonites offered up their children to Moloch. The *Pelasgi* at one time sacrificed a tenth part of all their children, in obedience to an oracle.

The *Egyptians* in Heliopolis sacrificed three men every day to Juno. The *Spartans* and Arcadians scourged to death young women, the latter to appease the wrath of Bacchus, the former to gratify Diana. The Sabian idolaters in *Persia* offered human victims to Mithras; the *Cretans* to Jupiter; the *Lacedemonians* and Lusitanians to Mars; the *Lesbians* to Bacchus; the *Phocians* to Diana; the *Thessalians* to Chiron.*

The *Gauls*, equally cruel in their worship, sacrificed men, originally to Eso and Teutate; but latterly to Mercury, Apollo, Mars, Jupiter, and Minerva. Cæsar informs us, that whenever they thought themselves in danger, whether from sickness or after any considerable defeat in war, being persuaded that unless life be given for life, the anger of the gods can never be appeased, they constructed wicker images of enormous bulk, which they filled with men, who were first suffocated with smoke, and then consumed by fire. For this purpose they preferred criminals; but when a sufficient number of these could not be found, they supplied the deficiency from the community at large.*

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* Strabo.

The *Germans* are said to have differed from the Gauls in having no Druids, and in being little addicted to the service of the altar. Their only gods were the Sun, Vulcan, and the Moon;† yet among the objects of their worship was Tuisto their progenitor, and Woden, the hero of the North. It is true, that neither Cæsar nor Tacitus say any thing of their shedding blood in sacrifice; yet the probability is, that, like the Saxons and other Northern nations, they not only offered blood, but took their choicest victims from the human race.

In *Sweden* the altars of Woden smoked incessantly with blood: this flowed most abundantly at the solemn festivals celebrated every ninth year at Upsal. Then the king, attended by the senate, and by all the great officers about his court, entered the temple, which glittered on all sides with gold, and conducted to the altar nine slaves, or in time of war nine captives. These met the caresses of the multitude, as being about to avert from them the displeasure of the gods, and then submitted to their fate: but in times of distress, more noble victims bled, and it stands upon record, that when Aune their king was ill, he offered up to Woden his nine sons, to obtain the prolongation of his life.

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* Cæsar Bel. Gal. 6.

† Cæsar, B. G. 6.

The *Danes* had precisely the same abominable customs. Every ninth year, in the month of January, they sacrificed ninety-nine men, with as many horses, dogs, and cocks: and Hacon, king of *Norway*, offered his own son to obtain from Woden the victory over Harold, with whom he was at war.*

In *Russia*, the slavi worshipped a multitude of gods, and erected to them innumerable altars. Of these deities *Peroun*, that is The Thunderer, was the supreme, and before his image many of their prisoners bled. Their god of physic, who also presided over the sacred fires, shared with him; and the great rivers, considered as gods, had their proportion of human victims, whom they covered with their inexorable waves. But *Suetovid*, the god of war, was the god in whom they most delighted: to him they presented annually, as a burnt offering, three hundred prisoners, each on his horse; and, when the whole was consumed by fire, the priests and people sat down to eat and drink, till they were drunk. It is worthy of remark, that the residence of Suetovid was in the sun.†

To this luminary the *Peruvians*, before they were restrained by their incas, sacrificed their children.‡

Among the sacred books of the HINDOOS, the Ramayuna demands particular attention, because of its antiquity, the extent of country through which it is revered, and the view which it exhibits of the religion, doctrines, mythology, customs, and manners of their remote progenitors.

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* Hallet's North Antig. 1. p. 134. † Levesque Hist. de la Russie. ‡ *v.* Robertson's America, vol. 3.

In this we have a golden age of short duration, succeeded by a state of universal wickedness and violence, which continued till the deity, incarnate, slew the oppressors of the human race, and thus restored the reign of piety and virtue.

This poem contains a description of the *Ushwamedha*, or most solemn sacrifice of the white horse, instituted by Swuymbhoo, that is, by The Self-existent. At the celebration of this festival, the monarch, as the representative of the whole nation, acknowledged his trangressions, and when the offerings were consumed by the sacrificial fire, he was considered as perfectly absolved from his offences. Then follows a particular account of a human sacrifice, in which the victim, distinguished for filial piety, for resignation to his father's will, and for purity of heart, was bound by the king himself, and delivered to the priest; but, at the very instant when his blood was to have been shed, this illustrious youth was, by a miracle, delivered; and the monarch, as the reward of his intended sacrifice, received virtue, prosperity, and fame.

It is well known that the Brahmins have, in all ages, had their human victims, and that, even in our days, thousands have voluntarily perished under the wheels of their god Jaghernaut.

In the *Islands of the South Sea* we find the same execrable customs; but the nation of all others most devoted to their idols, was the *Mexican:* they had forty thousand temples, endowed with land, and their priests were more than a million. The office of the high priest was to open the breast, and to tear out the heart of the victim, while five assistant priests held him naked, and stretched upon the altar. If this were a prisoner, the body was devoured by the captor and his friends: if he were a slave, purchased for the sacrifice, the purchaser and his family consumed the body.

The numbers thus destroyed were commonly, according to Clavigero, about twenty thousand annually, but the Franciscan monks limit them to two thousand five hundred; beside which, in March and April they sacrificed children, purchased for that purpose, and when the king died, all his slaves, with some of his wives, were compelled to bleed upon the altar.*

The *Caraibes* of the West Indies had altars, on which they offered their first ripe fruits, and the blood of their captives, not only to the Sovereign of the universe, whom they regarded as wise, powerful, and gracious; but to malignant spirits, to gratify whose delight in blood, they mangled their bodies with sharp instruments. It was thus that the priests of Baal wounded themselves, when taunted by Elijah with "Cry aloud, for he is a God: either he is talking, or he is pursuing, "or he is on a journey, or, peradventure he sleepeth, and must be "awaked—for they cried loud, and cut themselves with knives and "lancets till the blood gushed out upon them." This precisely is the custom forbidden to the Jews by Moses.†

How degrading is this picture to humanity! yet, whilst we lament over the cruel superstition of the pagan world, with its despicable rites and horrid sacrifices, we cannot but distinguish in this mishapen monster some features, which reminds us of its divine original. *Sed hei mihi! quantum mutatus ab illo!*—How is the gold become dim! How is the most fine gold changed!

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* Clavigero's Mexico.

† Deut. 14. 1.

That the Pagans derived their sacred rites from a more enlightened people, as far as relates to the Grecians, was confessed by them, and the same origin stands detected with regard to all the rest. This confession of the Greeks will be confirmed by what is immediately to follow.

Moses ordained, that the heifer, whose ashes were to be preserved for cleansing the Israelites from ceremonial impurities, should be one that never bore the yoke. Agreeably to this description, when Diomede, in Homer, was about to penetrate the Trojan camp, and had prayed to Minerva for assistance, he vowed, that he would sacrifice to her a yearling heifer, which no man had subjected to the yoke.*

And Nestor, when seeking her protection, repeats this vow—

> A yearling bullock to thy name shall smoke,
> Untamed, unconscious of the galling yoke,
> With ample forehead, and yet tender horns,
> Whose budding honors ductile gold adorns.
>
> POPE'S ODYSSEY, b. 3. l. 490.

We learn from the Jewish historian, that the separation of a particular family to offer sacrifice was by special appointment; but, that prior to the institution of a sacerdotal college, the patriarchs each performed this office for himself and for his household; as we see in the examples of Abel, Noah, Job, Abraham, and Jacob.

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* Hom. Il. κ. 292.

In *China*, the emperors are the sovereign pontifs, and none but themselves can offer sacrifice to the Tien. At their accession to the throne, and at the four great festivals, at the vernal and at the autumnal equinox, at the summer and at the winter solstice, they appear before the altar, where the ceremony is conducted with the greatest majesty and splendor. On these occasions, the emperor being surrounded by the princes and ministers of state, who are all prepared by previous retirement, by fasting, and by prayer, for the solemnity; the number and the choice of victims, the precious vessels, the musical instruments, and the deep attention of the multitude, display at once the dignity of the priest, and the greatness of that Being who is the object of their adoration.

How perfectly patriarchal is this practice of the emperor, who is regarded as the father of his people!*

Homer, who wrote near six hundred years after the departure of Israel from Egypt, shews clearly, not only that military chiefs were, like the patriarchs, both kings and priests, but that occasionally the most distinguished person in the company, without imputation of sacrilege, might perform these functions. Yet many nations, after the example of the Israelites, have deviated from the more simple path of nature, in appointing that the priesthood should descend by inheritance, and be confined to families.

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* *Maellá*, II. ch. 12.

Under the Levitical dispensation it was ordained, that no man, who had a blemish, although he were of the seed of Aaron, should come nigh to offer the offerings of the Lord, made by fire. He might partake of the sacrifices, but he was not to approach the altar.* The same provision was adopted by other nations and cities, particularly by the Athenians, among whom it was required, that whoever was admitted to the priesthood should be perfect, having no defect, nor any part redundant.

With respect to purification, what was the practice of the patriarchs we are not informed, but in after ages a laver was provided for Aaron and his sons to wash their hands and feet, before they approached the altar to minister and to burn offerings, made by fire, unto the Lord.† In conformity to this institution, we observe, that Hector was afraid to make even a libation to Jupiter without first washing; so, when Priam and Agamemnon were about to sacrifice, the herald poured water on their hands.‡ In imitation of Homer, Virgil makes his hero say to Anchises—

In me 'tis impious holy things to bear,
Red as I am with slaughter, new from war;
Till in some living stream I cleanse the guilt
Of dire debate, and blood in battle spilt.

DRYDEN'S VIRGIL.

Agreeably to this universal custom, Telamachus, in Homer, before he begins to pray, is careful to wash his hands. On more solemn occasions it was ordained, that the clothes likewise should be washed, as when the law was given on Mount Sinai, or when the Levites were to be purified and set apart for the service of the altar.

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* Lev. c. 21, v. 21.

† Exod. c. 30, v. 18.

‡ Hom. Il. l. 6. 266, l. 3. 270.

This practice was adopted in after ages by the Greeks, and therefore Homer makes Penelope conform to it, when she was about to pray.

If washing could not be commodiously performed, persons and things were to be sprinkled with water. We have one example of this, which is too remarkable to escape our notice. Virgil, when describing the solemnities exhibited by Æneas over his departed friend Misenus, represents some of his companions as constructing the funeral pile, whilst others are employed to wash and to anoint the body: some wailing after the manner of the ancients,* whilst others, taking up the bier, convey it to the pile. Here it is consumed together with the frankincense and oil, the oblation to his manes; and the smoaking embers are quenched with wine. The ashes are then collected and deposited in a brazen urn.

Thus far Virgil has borrowed from the Grecian bard, when he enumerates the funeral rites with which Achilles honoured the body of Patroclus. But the Roman adds, that when all this was finished, Chorinæus, the priest, thrice sprinkled the assistants with pure water, to cleanse them from the pollution they had contracted in this last office for the dead.

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* See Jer. G. 17. 18.

> Idem ter socios purâ circumtulit undâ
> Spargens rore levi et ramo felicis olivæ:
> Lustravitque viros.[*]

May we not here be permitted to conjecture, that the notion of defilement by the dead, and the consequent sprinkling, were derived from the law of Moses, since it is therein declared, that whoever touched a dead body was ceremonially unclean; and at the same time provided, that for his cleansing he must be sprinkled with running water, after which he was to wash his clothes and bathe himself, before he could be considered as free from his pollution.[†]

The original design of this symbolic action will be more particularly explained, when I shall proceed to speak of Moses as a legislator and a prophet.

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[*] Æneid, 6. 229.

[†] Num. 19.

SUBJECT V.

OF TITHES.

CONNECTED with the priesthood and with sacrifices, and therefore brought forward in this place, we may reckon the custom of tithing, which is of such antiquity, and so extensively diffused, as to claim one common origin with them.

Pliny assures us, that the Arabian merchants constantly offered tithes of their spices to Sabis. *Plutarch* mentions the custom of the Romans to devote a tenth part of their spoil to Hercules. *Lucian*, in his dialogues, takes notice of the tithe set apart for Mars; and *Pausanias* gives us the inscription of a golden buckler, dedicated to Jupiter by the Athenians, marking that it was the tithe of their victory, when they took and destroyed Tarragra. He mentions also the practice of miners in the islands of the Archipelago, to separate for Apollo a tenth of all their gold. From *Diogenes Laertius* we collect, that the Athenians paid tithes to Pisistratus, to be employed not for his private use, but in sacrifices and public services. *Diodorus Siculus* informs us, that when the Grecians had driven the Persians out of Greece, they presented a golden tripod to Apollo, from the tithes of all their spoils.

Xenophon speaks of tithe from a certain field, as being consecrated to Diana; and *Herodotus* has preserved the inscription of the Athenians on the brazen chariot presented to Minerva from the ransom of the Bœotians, stating, that it was the produce of the tithe.*

Considering the remote antiquity from which this practice dates, we may reasonably expect to find notice of it in the most ancient of historians Accordingly we read in the patriarchal annals, that Melchizedek, king of Salem, and priest of the most high God, received the tenth of all his spoils from Abraham, after the defeat of Chedorlaomer and of his confederates.†

Jacob appears to have been the first who bound himself by a vow, to give the tenth of all his increase to God.‡

But from Moses we learn, that after the delivery of the law, the tithe of all increase of corn, wine, oil, flocks, and herds, was holy unto the Lord.§ This was given for the maintenance of the priests, and for the service of the altar. It must be remembered, that the tribe of Levi had no landed inheritance with their brethren, and therefore, independantly of the divine command, they had an equitable claim to this provision.

In the Christian church, the priesthood sets up no such claim. Should therefore the legislature, in its wisdom, substitute any other mode of providing for the service of the altar, supposing that in this change no injury is done to individuals, with whom the community have contracted obligations, the plea of divine right can oppose no obstacle to the general good.

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* Herodot. l. 5, c. 77.

† Gen. 14. 20.

‡ Gen. 28. 22.

§ Lev. 27. 30. Deut. 14. 22.

It is probable that temporal princes claimed the tithe as representatives of the universal sovereign. In the Roman empire, the coloni paid this tax, which was collected by the decumani; and Colonel Wilks, in his interesting Sketches of Southern India, page 144, assures us, that a tenth is a traditional share, paid in India before the institution of the sixth. It is the proportion paid in the little principality of Coorg at this day, and the Dutch found and continued that tax in Ceylon.

SUBJECT VI.

OF THE DELUGE.

TRADITIONAL reports of an universal Deluge have been diffused and noticed in every nation upon earth. Yet these reports, whilst they agree as to the fact, are so various, and attended with such improbable circumstances, they carry with them such evident marks of fiction, that, although we remain persuaded of the general truth, we are compelled to disregard particulars, and to search for authentic records, by which we may gain more perfect information as to the nature and extent, the causes and consequences of this wonderful event.

The *Chinese* and *Japanese* annually celebrate their feast of waters, in which they traverse the rivers in their gondolas, crying "Peirun, "Peirun."

This *Peirun* was a wise and virtuous king, whose throne was established in a very fertile island, and whose subjects became so vicious, that they drew down the vengeance of heaven, in consequence of which the island was swallowed up by the sea. The prince, however, favoured by the gods, and forewarned of the dire event, saved himself and family in a ship, and having sailed to another country, disappeared, leaving no traces of himself behind.*

Among the *American* Indians, who are settled near Churchill River on the North-West coast of Hudson's Bay, we find the worship of two superior beings; the one good, the other evil. Of these, Ukkemah, the good deity, made the first parents of mankind; three males, and as many females, of different colours.

With this imperfect account of the origin of the human race, these savages retain traditional reports of the deluge, but here they substitute a beaver for the dove.†

In *Greenland* a mutilated tradition of the deluge has been noticed by Crantz, in which it is stated, that the world was overset, and that all mankind, except one, were drowned. Father Lafitau has given us a similar tradition, as preserved among the IROQUOIS INDIANS of North America, and Clavigero assures us that the MEXICANS had some notion of the same event.

Similar traditions prevailed among the nations of ancient Europe. This appears in Josephus, who quotes from Berosus, from Nicholas of Damascus, and from an Egyptian author, who wrote the Phœnician Antiquities.

To illustrate the same event, Eusebius quotes Abydenus, and Cyril refers to Alexander Polyhistor. Plato makes mention of a *general* deluge, and Plutarch speaks of a dove sent out from the ark by Deucalion. Ovid certainly represents his deluge as universal, and ascribes to Deucalion the character which belongs to Noah, and, like Moses, the Roman poet states, that the human race was thus punished for their incorrigible wickedness.

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* Kempfer's Hist. of Japan.

† Phil. Trans. vol. 60, p. 129.

Traditional reports have been collected and brought forwards by every apologist for revelation, from the first ages of Christianity to the present day, and may be referred to in Stillingfleet, Gale, and Ramsay: but independently of divine authority, the most convincing evidence is to be sought for in the records which remain engraved in the deepest mines, and on the most elevated mountains.

In the display I am about to make of this natural evidence, scattered over the surface of the earth, I shall simply state my facts, and then examine what inferences may fairly be derived from them. And for this purpose, I shall first explore one small tract of country, that the attention of the young geologist may not be distracted by a multiplicity of objects crowding at once upon his view. When he has surveyed this island, he may be the better qualified for more distant excursions, and be able to compare its strata and extraneous fossils with those of every other portion of the globe. He will be thus prepared to follow me in my general conclusion, and will be convinced that the Mosaic account of the deluge is agreeable to truth.

OF THE ORDER IN WHICH VARIOUS SUBSTANCES APPEAR.

As we proceed in a *North-West* direction from the sea coast at Chichester, by Andover to Pewsey, and thence, either by Sandy Lane and Kelloway Bridge, or by Pottern, Bradford and Bath, to Bristol, and through South Wales to the Irish Channel, we meet with various substances, which appear and vanish in succession. These are chalk, sand, marl, clay, and a variety of calcareous rocks, followed by red ground, beyond which we see coal, shut in by mountain limestone, and other rocks, which require to be particularly noticed. The same may be said of any line which runs parallel to the one here traced, whether to the N. E. or to the S.W. of it as far West as Dorchester, and as far East as the coast of Essex, Lincolnshire, and Yorkshire.

Should we direct our course due North from Dorchester, we shall have a beautiful line illustrative of this succession. About seven miles from Dorchester we meet with green sand under chalk, and beyond these we pass over, in their proper order, the calcareous rocks, which will be particularly described in the progress of this work, and then arrive, by the coal country, to the red ground which is in the vicinity of Bristol.

I. CHALK.

1.—Immediately on the sea coast at Chichester, as above mentioned, and along the most elevated parts of Hants and Wilts, particularly at Tidworth; to the South of Everly, it is milk-white, fine in its grain and smooth when cut, writes readily on wood, and is fit for the cooper, for whiting, for lime, and for manure. It is Creta Scriptoria of Linnæus.

2.—In descending the hills from Everly to the vale of Pewsey, a second bed appears hard, rubbly, and tinctured with green, improper for the uses to which the former is applied, and fit only for the highways.

3.—Under this we find what is, with us, called a malmy chalk,* unctuous to the touch, of a grey or greenish white, unfit for any of the fore-mentioned purposes.

The separation between each of these beds and the succeeding is not abrupt, but gradual: for, commonly, when contiguous strata, apparently formed by subsidence, occur, they mix and run into each other. Agreeably to this observation we find, under these beds, a rubbly bed of chalk with silicious sand, united by a calcareous cement.

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* Marga Cretacea, Lin.

Incumbent on the chalk, at Chidbury Hill and on Marlborough Downs, as in our Eastern counties, we have an alluvial bed of clay, which constitutes what is called wood sower land. It is so called because, although productive of the finest timber, elm, oak, and ash; it requires chalking before it can produce good corn.

II. SAND.

Descending from the chalk hills and elevated downs of Wilts, we meet with sand, of which we distinguish three varieties.

1.—The sand immediately under the chalk is *green*, and, by analysis, contains oxyd of iron. Examined by a convex lens, it appears to be principally quartz, rounded at the edges, with some perfect hexagonal crystals, clear and transparent, but exceedingly minute. This sand has small fragments of rubbly chalk, and granular particles of a dark green substance, which contain much iron not attracted by the magnet. It is very fertile, and forms the rich vales of Warminster and Pewsey.

2.—If, in our progress Westward, we turn aside either to Pottern on the one hand, or to Sandy Lane on the other, descending to a lower level, this *green* sand gives place to gray sand and calcareo-silicious sand stone called fire stone, which is used by brass and iron founders for their moulds, and is valued by cabinet makers for polishing their work. The Hall and Abbey of Westminster were built with this stone. So was London Wall, and, as I understand, Woburn Abbey. Few are the places in which this treasure has been brought to light, but the probability is, that it is every where attendant on the chalk, and that no where distant from this, we may expect to meet with the whetstone bed of Black Down in Devonshire.

3.—At a still lower level, as, for instance, at the foot of Beacon Down, in the way from Pewsey to Chippenham, we meet with *red sand*,[*] and passing through Sandy Lane, rise up, on this stratum, all the way to Lockswell Heath and Derry Hill. West of Devizes the same sand appears immediately below the clay at Foxhanger, and from thence rises up to Seend.

This sand is charged with iron ore, formerly in great request for the furnace and the forge. From this bed the ancient Britons had their quern stones, but now the rock is used, in this part of the kingdom, only for the roads. It is a pudding stone, composed of a rounded quartz, whose cement is silicious, with a red calx of iron. The sand of this stratum forms a very fertile soil, much esteemed for early crops.

Beneath these beds we find good clay, and at Road, near Devizes, over the red sand, is some of the finest brick clay I ever saw in Wiltshire.

III. THE SUPERIOR OOLITE.

To the West of these beds, at Calne, on Lockswell Heath, and in Bowood Park, we observe an *Oolite*, called free-stone, here quarried both for building stone and lime. For these purposes the excavations are extensive, and bespeak the goodness of the article.

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[*] Arena Ferruginosa, Lin.

In Lulworth Cove, Dorsetshire, all the preceding strata are at once submitted to our view. Thus over a cliff of this oolite, called Saint Aldhelmshead, we find clay, then, as we ascend, successively the red sand, with its quern stone, the grey sand of a yellowish cast, the green sand, the rubble bed, and lastly the chalk, covered by alluvial gravel and by turf.

This kind of stone, although not a marble, for it does not admit of a bright polish, is distinguished by Linnæus under the appellation of *Marmor Hammites*, that is sand marble, and is by him particularly noticed in Gothland, Saxony, Thuringia, and the Dutchy of Brunswick. It is the Rogenstein and Hersenstein of the Germans, so called from the resemblance of its component parts to fish spawn, and millet seed. It yields freely to the axe, the chisel, and the saw.

The name of *Oolite*, i. e. egg stone, or spawn stone, from Oον and λιϑος, answers well to the appearance of this rock. The appellation of *free-stone* is too general. Whenever this term is made use of, it should be considered as generic, and the species should be distinguished into calcareous, silicious, and calcareo-silicious, or calcareous grit. As the rock in question makes good lime, it may with propriety be called a calcareous free-stone, but oolite is a more characteristic appellation.

IV. CALCAREOUS GRIT.

At a lower level, to the West of Calne, on Derry Hill, and also a little to the West of Seend, a calcareous grit, or rock of silicious sand, with calcareous cement, is obtained both for building and for the repair of the high ways. It rises in large blocks, is bedded in silicious sand, strikes fire with steel, and ferments with nitrous acid.

It is excellent for the repair of the highways.

V. CORAL RAG.

Under the preceding rock, at Westbrook in Bromham Parish, and to the North of Calne, is now procured a hard and ragged stone, which is a mass of coral, used both for lime and for the repair of all the circumjacent roads to the distance of many miles. This treasure, till within the last fifty years, was hid, and prior to its discovery, the surveyors went twelve miles for flints to mend the highways, under which this rock is found. Subsequent to that period, the coral rag has produced more than ten times the fee simple of the land, on which it is procured.

In our progress Westward from Seend, we meet the same rock at Steeple Ashton.

It derives a bluish grey colour from its superincumbent marl, is very hard, ponderous, and susceptible of high polish; but is rubbly, and, as far as my knowledge goes, never rises in the form of blocks.

VI. KELLOWAY ROCK.

The next calcareous stratum, first attracted our notice, at Kelloway Bridge, in the high road from Calne, by Bremhill, to Malmesbury. But if, in our progress to the West, we turn aside to Steeple Ashton, or follow the line of the Kennet and Avon Canal to Lady Down, there we meet it again. It is used only on the roads, because no slabs can be obtained from it.

It may be readily distinguished by its fossils, which will be particularly noticed.

VII. CORN BRASH.

Under the preceding comes a rock known by the name of corn brash and corn grit. The latter appellation however is improper, because it is not a grit. This brashy, or ragged, calcareous rock, with its fragments rounded at the edges, may be noticed as they are turned up by the plough, either round Atford, and at Wraxall, or at Chippenham, with the interjacent country. It is light in its colour, close in its grain, and, being rubbly, is not fit for any purpose, excepting for lime and the repair of the highways.

It may be readily discovered by the superincumbent red soil which constantly attends it.

VIII. FOREST MARBLE.

Proceeding from Atford, toward the Setting Sun, the next rock we meet with is the forest marble, a calcareous rock, so called because first procured for slabs and chimney pieces in the *Forest* of Deane. Should we direct our steps through Staverton to Wooly, in our way to Bath; we should rise on the surface of this rock, and see it in every quarry on the road side. In many places, as at Wooly, Bradford, and Hinton, it has a covering of silicious sand and sand stone. It is compact, susceptible of high polish, and may be procured in considerable slabs.

It contains small fragments of coal.

IX. THE GREAT OOLITE.

Having left all these behind us, and proceeding to the West, at Bradford we come to the great *Oolite*, or free-stone rock. The latter appellation is provincial, and indicates the facility with which, when first taken out of the quarry, it yields both to the chisel and the saw.

This is the rock by which Bath is almost every way surrounded, and to which it is indebted for the exquisite beauty of its edifices. From Bradford we ascend on this rock to Winsley, and meet it again on Claverton Down, from whence we may trace it to the West, on the summits of all the hills near Bath. Its beds are all calcareous, but not all free stone, that is, oolite, for many of them are composed of broken shells, united by a calcareous cement, and consequently do not readily yield to the chisel and the saw. It is said to consist of carbonate of lime, 90; alumine and iron, 10: but its contents are various.

X. THE INFERIOR OOLITE.

Between this rock and the preceding, we meet with one, which, as being of little consequence, and of no utility, I here pass unnoticed.

West of Winsley, near Stokebridge, in the canal, we first meet with the inferior oolite, commonly called *bastard freestone*, which, near Bath, is unfit for use, because it is soft and abounds with vacuities, although in other districts, as at Painswick, it yields some beds of the most perfect free-stone.

It every where reclines on calcareous sand, which is used by our cooks, at Bath, to sand their kitchens, and is procured for them on the hills behind Camden Place, and Sydney Gardens. This rock, to the South of Bath, forms Beechen Cliff, and to the North, it appears abrupt, in Mount Beacon, behind Walcot Parade, and at Bath Easton.

It beds on blue marl, in which are two rocks, one called Yeovil marble, the other marl-stone. The former, about Bath, has no blocks, but is highly interesting because it yields copious springs.

XI. THE LYAS.

Proceeding Westward on both the Bristol roads, the lyas beds appear separated by intermediate beds of marl and clay. These may be seen in the greatest perfection at Twiverton and Keynsham, or in the quarries opened by the way side between Bath and Bitton, where, in the depth of twenty feet, you may distinguish thirty or forty beds.

All the preceding strata are separated by argillaceous beds, and the great mass of lyas is recumbent on blue marl, constituting the richest soil of Somersetshire, and of that part of Gloucestershire which borders on the Severn.

In its texture, solidity, and freedom from all appearance of granulation, it answers to the *dickt kalkstein* of the Germans.

The blue lyas contains much iron, makes strong lime for water works, and is good building stone. The white lyas takes high polish, and may be readily engraved. It is now in request for the calico printers, for maps, and for some kinds of drawings, in which service it is a valuable substitute for copper-plates.

XII. RED GROUND.

Beyond the Lyas district, we meet with the red ground at Hanham and at Kingswood, or we may trace it below Newton, to the West of Keynsham, and at Brislington, on the lower Bristol road.—But near Bristol, its rock was exhibited in great perfection South-East of the city, when the new channel of the river was formed, and may with great advantage be viewed at Stapleton. The red marl of this stratum is the most fertile land in Britain. It abounds with iron, and covers various beds of sand rock, of pudding stone, and of schist, composed of ferruginous argillite, with mica, called pennant stone.

XIII. COAL AND SUBJACENT STRATA.

The red ground leads to *Coal,* beyond which, to the West, we observe mountain lime-stone, iron, argillaceous and silicious schist, pudding stone, porphyry, gneis, micaceous schist, and granite. Between these occasionally basalt appears, but not in the vicinity of Bath.

Such is the usual succession of strata; but in some places the intermediate beds are wanting, and therefore at Chard the chalk and lyas meet together; and the oolite reclines in Portland, on the lyas beds, but at Mells upon the mountain lime-stone.

SUCCESSION OF STRATA IN OTHER COUNTRIES.

SUCH is the order, and such the local situations, in which these substances appear upon the surface; and, wherever perforations have been made, whether for canal navigation, for water, or for coal, the same order has been almost constantly observed. This regular succession is not, however, confined to England and to Wales.

In IRELAND, *granite*, wherever it appears, gives a base to schist, and borders on the districts of mountain lime-stone, coal, and iron. In Kilkenny it occupies the intermediate space between the Barrow and the Nore, and is the termination of a chain of mountains, which rise in Wicklow, occupy an area of a hundred and forty square miles in the centre of that country, pass through Carlow, and, including the granite mountains of Leinster, Blackstairs, and Brandon, proceed to join those of Waterford. These granite mountains, steep to the E. N. E. and sloping gently W. S. W. support schist, as that does the mountain limestone. The same arrangement is found in the Galtee granitic chain, which runs from N. E. to S. W. parallel to the *Shannon*, and separates Limerick from Tipperary, for between this river and the granite, we have the Ballyhowry mountains, which are composed of slate, and at a proper distance from the central chain, the lime-stone appears.

Such is the general arrangement; but to be more particular,

Antrim, and the North coast of Donnegall, have chalk with its subjacent green sand. This part of Ireland is highly interesting, and requires more minute attention than I was able to give it when I visited that country.

London-Derry, North of the Roe, has lime-stone, and to the South of it slate, with coal, but to the West is granite, rising up through schist, which supports lime-stone and coal.

Down has granite, slate, lime-stone, and iron.

Leitrim, from Ballyshannon to Sligo, has lime-stone.

Longford exhibits granite, near Bally Mahon.

Mayo has granite, slate, coal, iron, and black marble.

West Meath is a lime-stone gravel, extending through the King's County and Tipperary.

Queen's County has limestone, coal, and iron.

Limerick, and the County of *Cork* exhibit lime-stone, slate, and granite.

Wicklow has granite, but South of the Seven Churches I observed slate.

In *Wexford*, Loftus Hall has lime-stone; Newtown Barry has slate; and the Galtee mountains are granite.

Kerry contains lime-stone, coal, and iron.

Wexford and *Waterford*, on the South coast, have mountain limestone, succeptible of the highest polish.

Of the county of Kilkenny we have a most interesting account, for which we are indebted to Mr. William Tighe, a gentleman who happily unites clearness and precision to extensive information. After noticing the central chain, he traces in succession all the superincumbent strata. In that county silicious schist lies up against the granite, and lower down appears the argillaceous schist, containing mica, and covered by boulder stones of quartz and granite.

Silicious breccia, used for mill-stones, forms many of the lower hills, lying on silicious schist, which runs East from Sliegh-ra-man along the Southern borders of Kilkenny, and is constantly attended by red argillite, which covers the sides of the hills, but not their summits. It contains much mica, and is called red slate. It is more copious on the northern than it is on the southern hanging oi these hills. Other hills of the same nature run N. E. from these. This silicious breccia is sometimes found contiguous to a fine grained white sand-stone, of quartz, with a silicious cement. At a lower level is slaty argillite, of which extensive quarries have been opened.

Ferruginous argillite, attended by silicious schist, which varies into argillite with mica, occupies the northern part of the country. This constantly appears above the coal, and is used for flag-stones.

In this description we see distinctly all the features of our red ground and pennant stone, under which, as in England, *dons*[*] succeed and give a covering to the beds of coal.

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[*] Schiefer Thon, of Werner.

The iron stone, as with us, appears in flatted nodules between beds of slate, and the coal district is surrounded by mountain lime-stone.

In SCOTLAND, granite rises magnificently on the western coast of Galloway, stretches itself to the North-East, and sinks at last into the German ocean. Parallel to this, two other chains extend from sea to sea: of these the most elevated is known by the name of Grampian Hills.

Recumbent against all these we observe schist, succeeded by a chain of mountain lime-stone, *beyond* which coal is found.

Passing through FRANCE and SPAIN I took notice of the same connection and succession.

Chalk hills appear in the high road to Paris, all the way from Calais, Boulogne, Montreuil, Abbeville, Amiens, and Clermont, to St. Denis, and in the whole country between these limits, westward to the English channel. South of this district the chalk continues, and may be traced through higher Normandy, Picardy, Champagne, and Burgundy, covered, as in England, by its thick bed of clay and sand, which extends forty leagues from S. E. to N. W.

Granitic mountains stretch from South Burgundy through Forez, Auvergne, Limonsin, and Perigord, till they gradually sink and lose themselves in the landes de Bourdeaux. The centre of this chain is highest, but the most perfect granite occupies the elevated region of Chanteloube, not far from Limoges. In Auvergne it is found only in depth whilst the tops of the mountains are micaceous schist. Granite occupies the sea coast and sands from Cherbourg, in Normandy, through Britany, Poictou, Guienne, and Gascony, to the Pyrenees. In Guienne we return to the chain already traced through Auvergne.

To the North-West of this chain, sand hills separate between micaceous schist and lime-stone hills, which are both numerous and lofty, and extend to the Dordogne. From Auvergne to the *chalk* hills, north of Paris, calcareous rocks are visible, alternating with sand-stone.

As I travelled through the Southern provinces of France, towards Spain, from Auxere to Vermanton, I met successively with *chalk*; then free-stone, lime-stone, silicious and argillaceous schist, and finally with granite. In ascending the Pyrenees from Roussillon, after I had lost sight of lime-stone, I saw nothing but schist to the very summit of the mountains, beyond which to the South, these strata are visibly supported by granite.

Having entered SPAIN, we descend from the Pyrenees, which, throughout the whole extent, have the same strata; and at Gerona I remarked pudding stone, schist, and granite.

At Daroca the schist is covered by its lime-stone.

In proceeding Northward from Madrid, towards the Bay of Biscay, *granite* occupies the whole tract as far as Valladolid, where the *schist* and *lime-stone* appear, and are succeeded in the Asturias by *coal*, *lime-stone*, *oolite*, and *chalk*. The chain of mountains between the two Castilles is every where granitic, and so is the southern chain of the Sierra Morena; but wherever granite occurs, it supports first schist, then mountain lime-stone, which, in the south of Spain, becomes fine marble.*

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* See my Spanish Travels.

Portugal, separated from Gallicia by lofty mountains, exhibits the same succession of strata as I have already noticed in England, in France, in Spain. On its northern frontiers, where all is granite, the most elevated chain is called Serra *de Gerez*, that is *Juressus*, and the most lofty peak called Murro de Burrageiro, is raised about three thousand feet above the level of the sea. The attendant mountains stretch Southward to the Douro, whose bed exhibits sand-stone. Proceeding from this river to the South, we rise up over silicious and argillaceous schist, 'till we approach the granite chain of *Estrella*, supposed to be the highest in the kingdom. This rises gently from the North, but to the South is exceedingly abrupt.

It is here worthy of attention, that in the inferior branches of this chain, sand-stone, not schistous, frequently covers the schistous sand-stone, and contains quartz grains, few in number, but large, and rounded at the edges, whilst in the schist there are numerous, yet small crystals of quartz, with their angles perfect, attended by much mica.

These mountains are surrounded by others of sand-stone, as the latter are, particularly in Beira and Estremadura, by lime-stone, which is there more elevated than most of the granitic chains.

Near Lisbon the progress is distinctly seen from granite to sand and lime-stone. At the mouth of the Tagus, the Northern Cape is granite, the Southern is mountain lime-stone.

To the South of this we trace the coal beds. The prejudice against the use of coal is so prevalent in Spain, Portugal, and France, and the want of capital is so discouraging to the spirit of adventure, that in these kingdoms few coal districts have been explored.

At Elvas, near Badajos, on the Guadiana granite prevails; and over it we see the sand and lime-stone in their due position. To the West of Elvas, Montemor, in the centre of the province of Alentejo, is granite, and so are the mountains North and South of it, stretching from Port Alegre to the Tagus, and from Evora to Serpa, on the Guadiana.

In the South of Portugal, near Cape St. Vincent, we have two lofty chains of granitic mountains. These are the Serra de Caldeirão, and the Serra de Monchique, both supporting on their backs first schistous sand-stone, then lime-stone, the latter of which forms the Cape.*

By the observations of travellers in Europe and in Asia, it appears that one general law prevails. If we attend them to the Caucasian mountains, whose stupendous cliffs are covered with eternal snow, we shall be confirmed in our opinion, that the regular succession is from granite to sand-stone, with argillaceous schist, and thence to coal and to the calcareous rocks. For near to the granite, both to the North and South, are mountains of *slate*, then *lime-stone*, *coal*, and finally *chalk hills*.† The Crimea has lime-stone reposing on mountains of schist; but the granite and gneiss rocks here seem to retire from our sight, yet they have left behind much glittering sand of yellow mica.‡ The whole of its Southern coast, from Balaklava to Kaffa, has tremendous cliffs of mountain lime-stone; but the most elevated are West of Alushta. A few versts only from the shore, they rise more than a thousand or twelve hundred feet above the level of the sea; and Tshatyrdag, extending its naked crest from East to West, through a long line of country, is higher than its neighbouring mountains by at least two hundred feet. Such is their elevation.

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* See Link's Travels in Portugal, and his Mineralogical Tracts. † Pallas' Southern Tour. Pleschef's Russian Empire. Tooke's Ditto. ‡ Guthrie's Crimea. Pallas Ditto, and Dr. Clarke's Russia.

Under the waves their depth has never been explored; for within one verst from shore no soundings can be had. As we proceed Eastward from Alushta, the whole breadth of this stupendous range of ruptured mountains may be computed at about twenty versts, that is about thirteen miles.

These decline towards the North, covered by argillaceous strata and beds of silicious schist, of a ferruginous aspect, containing mica like our pennant stone, and sometimes covered with quartz crystals. Attendant on these strata are others of silicious mill-stone, with grains of quartz, connected by a calcareous cement. Over these are spread a covering of marly schist, in some places exhibiting vestiges of charcoal. The lofty series of strata near the River Karasu, that is black water, called Akkaya, that is white mountain, are cretaceous, and contain flint within the *chalk*.

Near the vale of Sudagh, the mountain lime-stone is incumbent on mill-stone, and in various other places, instead of this, brown schist and slate appear.

Some mountains are composed of pudding-stone, either compact, or in a state of decay and form extensive banks of *Shingle*, that is rounded gravel, such as appears on the sea beach.

The nearest visible granite is on the northern borders of the Mæotic Lake, or Sea of Azof, and the nearest coal seems to be under that lake, as appears by the matters ejected from volcanic craters in the isle of Tamar. The same succession of strata is again repeated to the North of Taganrog, where coal is attended by mountains of schist, lime-stone, and granite, each in due succession.* As we approach the Valday mountains, coal becomes more abundant.

Still further to the North, from the White Sea and Nova Zembla, the Ural or Riphæan mountains stretch away to the South-West. These, like all other elevated chains, have their central ridge of granite, supported by schist and lime-stone, above which *chalk* and gypsum are particularly noticed.†

In leaving the *Ufa* which empties itself into the Belaia, and thence by the Kama into the Volga, the first hills have strata falling to the West. Near the Sim they dip Eastward, and in this stupendous chain we meet, first mountain lime-stone, then slate, and various species of sand-stone, then quartz and feldspath, which, to the East, are mixed with horn-stone and jasper, after which appears the metalliferous rock, with granite and some gold; and in the inferior districts abundance of china clay.‡

The *Valday Mountains* have granite in their central chain; but on their Western, Southern, and Eastern declivities, they exhibit the usual superior strata, which terminate in *chalk*, as may be seen in the vicinity of *Moscow*, and the great oriental plane extending towards Tobolski. The same substances have been observed on the mountains attendant on the *Baikal* Lake, in the most elevated part of the Russian empire, to the North of China.

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* Pallas Southern Russia.

† Pleschef's Russian Empire. Pallas Voyages.

‡ Pallas Voyages, t. 2

The *Altay Mountains*, running East and West through Asia, rise two thousand eight hundred and fourteen feet, and are granitic.*

In the *Ægean Sea* the islands of Lemnos, Lesbos, Tenedos, and Naxia, have high mountains, whose base is granite, covered by schist and marble, which, like our mountain lime-stone, gives birth to abundant springs. Near Constantinople the schist is attended by coal.†

The *Carpathian Alps*, rising eight thousand six hundred and forty feet above the level of the sea, are granite, covered by gneiss, slate, and lime-stone, which last is in some places found incumbent immediately on granite. Their most elevated mountains are granite, but the common alpine rocks are slate, and the lower hills have lime-stone.

The *Tyrolian Mountains* are likewise granite, covered with slate. The whole chain separating Bohemia from the upper Palatinate, and that which, from Bavaria, runs to the circle of Eger, are granite; but near Eger the lime-stone appears.

We may observe generally, that in Saxony, Bohemia, Hungary, Wallachia, Transylvania, and all the high mountains of Europe, the strata are—1. Granite; over which is, 2. Gneiss, slate, and argillaceous rock; 3. Lime-stone; 4. These are covered by coal, slate, clay, sand, and calcareous earth, &c.‡

M. de Saussure, speaking of Sallenche, remarks, that the succession of strata is lime-stone, slate, primitive schist, and granite, and he adds—"as it commonly happens in alpine chains."

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* Tooke's View of the R. Empire.

† Olivier's Ottoman Empire.

‡ Baron Born's Travels in the Bannat.

A line drawn from Hamburgh to the central Alps meets with three chains of granitic mountains, in each of which the above observation is confirmed; and it has been particularly noticed by Baron Born, that Blocksberg, the highest mountain in the Hartz, and which is in the first of these chains, is composed of grey granite, covered with slate, as the slate is with lime-stone.*

East of the Hartz is Blankenberg, in which M. de Luc saw schist under lime-stone and over silicious grit. The continuation of this chain in the Rhætian Alps has the same succession of lime-stone, schist, and granite.

Armstrong, in his *Minorca*, enumerates the same strata; but does not give us their relative situation and succession. We have unfortunately the same defect to complain of in Sir George Staunton's account of *China*. Yet even here, twenty miles North of Pekin we read of *chalk*, beyond which appear calcareous hills, with coarse grained lime-stone, and ultimately the lofty Tartarian chain of granitic mountains. He mentions two other granitic chains running East and West, one through the province of Chan Tong, the other separating Konangsi from Konang Tong, but says nothing of their appendages.

The great table land of India, with the granitic mountains of the Mysoor and of Coimbetoor, rises gradually to the Westward as far as Balroyndroog, Soobramanee, and Taddiandamole. The latter mountain of this chain is elevated five thousand six hundred and eighty-one feet above the surface of the sea. The central part of this granitic table extends from Nundydroog, in the North, to Paulamulla, in the South, of which mountains the former rises four thousand eight hundred and fifty-six feet, and the latter four thousand nine hundred and fifty-eight feet above the level of the sea. But even to the water's edge, whether of the Bay of Bengal or of the Indian Ocean, the whole of Indostan, South of the Kistna, is granitic.*

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* Travels in the Bannat.

In the Philosophical Transactions for 1789, we have a very interesting account of the country between the extensive plains or *Bahar* and the high mountains of *Tibet*, by Mr. Saunders. In his progress he took notice of *chalk*, *lime-stone*, *slate*, and *iron stone*, with numerous springs and well wooded mountains, distinguished by their verdure even to the borders of Boutan. But in descending by the barren and extensive plains of Tibet to *Tishoolumboo*, he met with sand hills, quartz crystals, *granite*, *hot springs*, and much alluvial gold.

Beyond the *granitic* country of Mysoor, is found lead ore, like that of Derbyshire, with cinnabar and copper, which indicate the vicinity of mountain lime-stone. Beyond these limits come schist, with iron ore; and on the confines of *China*, *coal* is found. Thus we see granite inclosed between the usual schistous and calcareous strata.

Africa has not been much explored. Yet we know, that in *Egypt* schist covers the granite, which, near the cataracts, lifts itself up to view. In Denon's account of Egypt, between Kittah and

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* *v.* Dr. Buchanan's India.

Kossier we read of silicious schist and granite; and in Bruce's Travels we trace repeatedly the progress from granite to porphyry andmarble, and find all these united in the mountain of Terfowey.*

In upper Egypt, Sonini particularly noticed the calcareous rocks, where we might naturally look for them, at Siout and Echmim.†

Vaillant, who traversed a vast extent of coast near the Cape of Good Hope, penetrating three hundred miles inland, observes, that the mountains over which he travelled, are granitic; but neither he nor Thunberg enable us to trace the usually attendant schistous and calcareous strata.

From different travellers we collect, that all the extensive lakes in *North America* are contained between the granite and the lime-stone.‡ Montreal and Quebec are surrounded by the latter, but to the N. E. is seen the former. Fort Oswego is on granite, but Saratoga is on sand-stone. Along the coast, granite prevails from the mouth of the River St. Lawrence by Halifax, to Norfolk, in Virginia, to Hudson's Bay, and to Labrador, which is granitic, and yields the most beautiful field spar; but to the Westward of the granite, sand-stone, argillaceous schist, and lime-stone succeed, each in its proper place. Indeed a long chain of mountains running from N. E. to S. W. from Lake Champlain to the mouth of the Ohio, bound to the United States.§ Winnipeck Lake, which is not more than two miles wide, has to the West high cliffs of mountain lime-stone; but to the East, cliffs equally high of granite, steep on the shores and declining gently towards the East.*

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* Bruce's Abyssinia. † Sonini's Egypt. ‡ Makenzie's Voyages. § M. de la Rochfoucault's America.

Coal has been principally found in the Western provinces of the United States, beyond the Allegany mountains; and there also salt springs are most abundant. The general range of mountains West of Virginia is N. E. and S. W. and the lime-stone rises sometimes perpendicular. West of these mountains, the lime-stone, the schist, the free-stone, and even the coal, are arranged horizontally.

Dover coal mine, near Richmond, in Virginia, is twenty-four feet thick, and lies on granite.†

West of the Misissipi the mountains change, and rise again towards the Pacific Ocean.

Along the whole extent of the Western coast, from North to South, granitic chains prevail; and at Port des Français, in 58° North latitude, these mountains are so steep that, after the first six hundred yards, the wild goats cannot climb them. They are immense glaciers, whose base is washed by the sea, and at a cable's length from the shore the soundings are one hundred and sixty fathom.‡

From Humboldt we learn, in general, that all the high mountains of the Andes are porphyritic, and that granite appears only at a lower level, in the vallies, covered by gneiss, micaceous schist, porphyry, and occasionally, by basalt.

In his Political Essay on New Spain, he states, that Acapulco is shut in by granite mountains, two hundred and thirty toises high, and that in the mountains of Mixteca and Zapoteca, as far as the Western coast of Guatimala, only granite and gneiss appear.

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* Volney's America. † La Rochfoucault's Travels. ‡ La Perouse Voyage.

To the North of this granitic region, from 18° to 20°, nothing but basalt, amygdaloide, and porphyry are found.

From 21° to 25° the mountains are metalliferous, and the richest mines are in the provinces of Guanaxnata, Zacatecas, St. Luis, Potosi, and Durango.

Beyond these limits, in lat. 32° coal mines are wrought. In the intermediate space, mountain lime-stone most probably maintains its place.

In Chili, the external chains of mountains are stratified, their summits are calcareous, and they abound with marine productions. These are incumbent on a reddish whetstone, beneath which repose beds of clay, marble, schist, and coal. Under these are found porphyry and granite.*

In short, whether we examine Europe, Asia, Africa, or America, the same arrangement may be traced; with this exception, that both in our island, and over the surface of the globe, in some places, the superior strata are deficient, and may be supposed to have been carried off, after they had been deposited in the bosom of the ocean.

This arrangement, as already stated, includes granite, gneiss, slate, and argillaceous schist, mountain lime-stone, coal, schist, calcareous rocks, with clay, sand, chalk, and its integument of sand and clay.

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* Molina's Chili.

THICKNESS OF THE STRATA.

THE thickness in all these strata is extremely various, both when compared with each other and with themselves, in different places. I shall therefore be contented with giving the usual thickness, as nearly as may be, from the best information I have been able to procure, and from the observations I have made in the West of England, and on our Southern coasts.

I. THE CHALK.

The chalk has been commonly estimated at three hundred feet. At Selbourn, in Hampshire, this, by actual measurement, has been found, as Mr. White informs us, to be its thickness. On Canford Heath, in Dorsetshire, it is two hundred and eighty feet. In the Isle of Wight it has been laid open to the depth of two hundred feet; but at Slindon, near Chichester, Lord Newburgh's well is sunk three hundred and twenty feet, in chalk. At Sline House, near Warlingham, in Surrey, Mr. Banion sunk his well three hundred and twenty-six feet, through the chalk, and yet his house is not on the hill, but in the bottom. At Sanderstead the wells are three hundred and sixty feet deep. At Wimbledon six hundred feet, including the superincumbent alluvial beds. In Kent, by the assistance of my valuable friend General Donkin, I have been particularly fortunate in procuring measurements of four wells, on the chalk ridge, near Settingbourne. At Torry Hill, on the summit of the ridge, the well is three hundred and sixty-three feet deep, and the water rises sixty feet in the well.

A mile further on the same ridge, at Minsted, Mr. Patterson's well is three hundred and ten feet deep, and contains seven feet of water.

Mr. Tylden's well, at Milsted, a mile lower down, is two hundred and twenty-eight feet deep, and the water rises fifty feet.

At Sittingbourne the wells are twenty feet deep; and below Sittingbourne the springs break out.

In all these wells, the water undoubtedly flows on the same bed of clay which appears under the chalk in the higher parts of Wiltshire.

These wells are sunk in *chalk*, and the well diggers find water before they get through the bed, that is, when the pressure of water upwards overcomes the resistance of the chalk to its ascent. This perfectly accords with the well-known laws of Hydrostatics.

The well at Dover Castle was sunk three hundred and sixty feet through the cliff, and contained twenty-one feet of water in September, 1784. Lord Spencer's well, at Maidstone, is the same depth.

I have no doubt, therefore, that the whole thickness of the chalk stratum is more than four hundred feet. My valuable friend, Mr. Parkinson, states the upper bed at six hundred and fifty feet.

II. THE SAND.

The sand beds are of uncertain thickness.

From Devizes turnpike to Bulkington and Polshot, the fall is two hundred and seventy feet, the greatest part of which is sand. At Pottern Parsonage, which is at a much lower level than Devizes, the well is one hundred and twenty-six feet deep, chiefly in grey sand. Yet neither at Pottern nor at Devizes do we find the stratum of green sand, which shews itself at Ashelton Hill, East of Devizes, under the malmy chalk. From the extensive quarries of *Swindon*, which are two miles North of the chalk hills and of the green sand bed, I am favoured with the subsequent admeasurements.—1. Under the vegetable earth is lime-stone, six feet; 2. Wall-stone, apt to be split by frost, four feet; 3. Sand, with soft stone, twenty feet; 4. Hard stone, fit for pavements, from five to nine feet

In the no less extensive quarries of *Meestham*, in Surrey, they have—1. Green sand, fourteen feet, covered by chalk; 2. Fire-stone beds, fifteen feet; 3. Blue clay, twelve feet. The stone bed throws out the Surrey springs on the bed of clay. Here we seem to catch the beds which lie over the Swindon quarries; but the green sand does not maintain its proper thickness. Indeed on the declivities of hills such deficiency must be expected. From this circumstance, the same beds under Shotover Hill are exceedingly confused; and the quern sand, with its iron stone, the blue clay, grey sand, and the subjacent beds have met together.

Near Sidmouth, as I am informed, the quern sand alone is one hundred and fifty feet in thickness: but this must have been produced by dislocation.

On the whole, the sand beds together cannot be much less than three hundred feet in thickness. The subjacent bed of clay has not been sufficiently explored, but near Devizes it is seen on the Western declivity, in the lock pits of the canal, going down to Foxhanger, where it is near two hundred feet in thickness.

III. THE SUPERIOR OOLITE.

By the extensive quarries opened on this rock in Bowood Park, and at Calne, West of the London road, it appears to be about forty feet thick. It is covered by yellow clay, and rests on blue marl, of about twenty feet in thickness. Respecting the thickness of this bed in other parts of the kingdom, I have not sufficient information.

IV. THE CALCAREOUS GRIT.

This rock, wherever I have traced it, appears broken, and of uncertain thickness, but in some places, as for instance, West of Calne, where the canal passes under the Bath road, by a tunnel, it has been found about eight feet thick. At Derry Hill, one well has been sunk through it, with its covering of marl, twenty-two feet; but at Mr. Dickenson's Farm, the well is thirty feet through the same marl, and the same calcareous rock.

Under this we find a stratum of blue marl, of uncertain thickness.

V. THE CORAL RAG.

This rock, at Westbrook, near Calne, appears to be eight or ten feet thick; but to the North of Calne its thickness is increased considerably. At Lyneham Green, it is near thirty feet thick, with an intermediate bed of clay. In the former of these places, both the covering and bed are blue marl: in the latter, the covering is rich black loam, and the subjacent bed is blue clay.

Under this rock, in lower Colwell Wood, near Spy Park, another bed of calcareous grit appears; but in no other place have I met with it beneath the coral rag. Under these strata we have one called clunch clay, with a mixture of marl, sand, shale, and even thin laminæ of coal. This argillaceous stratum, the Wilts and Berks canal has taken for its bed, and from Semington towards Abingdon, it is at least two hundred feet in thickness. The appearances of coal in this bed has given rise to numerous trials, encouraged by ignorance or fraud. Among these, I remember one at the expense of Sir Edward Baynton and the Marquis of Lansdown, to the S. E. of Tetherton. A much more rash adventure has, I understand, been set on foot in Sussex, in the same bed, at the expense of Thirty Thousand Pounds, without a possibility of finding any thing more than thin laminæ of coal, from which no profit can arise.

VI. THE KELLOWAY ROCK.

This bed is from three to six feet in thickness, and lies on blue marly clay of uncertain thickness.

VII. THE CORN BRASH.

At Road and Woolverton, near Bath, the corn brash does not exceed twelve feet in thickness; but as it is only used for mending the highways, its thickness has been little noticed. It is covered by red clay, and beds on white clay, about one foot, under which we have seven feet of blue marl and clay.

VIII. THE FOREST MARBLE.

This rock is reckoned about forty feet in thickness, but in some places it seems to be considerably more. Its attendant silicious sand, at Winsley, at Bradford near Mr. Clutterbuck's, and at the entrance to Hinton, is not more than one foot thick: but proceeding South, this bed grows thicker, and both in a field of Mr. Day's, at Hinton, and at the Rose and Crown, it is at least thirty feet. In Farmer Collier's premises, at Norton, it measures twenty-nine feet of clean forest marble, separated into beds by fourteen feet of clay. The white clay on which the whole reclines, is of uncertain thickness.

At *Bruham*, near the *chalk* hills of Bradly Nole, a pit has been most preposterously sunk for *coal* through most of the preceding strata, to the depth of six hundred feet, and the bottom of the pit is in the uppermost beds of the great oolite.

IX. THE GREAT OOLITE.

At Bradford, we have a section of this rock on the Southern margin of the river, in a very bold and striking cliff. From the bottom of the cliff, Brimstone well issues on a bed of yellow clay. On the top of the cliff, elevated eighty-eight feet above the well, is a stone quarry, in which the beds dip very fast towards the South.

It is evident, that here we have lost the argillaceous covering of the rock: but a little to the South of this summit Mr. Hobhouse has a quarry, on whose flat roof I find all the peculiar fossils of this covering in vast abundance, bedded in white clay. This rock, therefore, South of Bradford, must be about one hundred feet in thickness. Whenever Mr. William Smith publishes his most interesting work, we shall have a distinct enumeration of all the beds of this inestimable rock.

On Farley Down, near Bath, where extensive quarries have been opened to procure building-stone, the rock appears to be one hundred and thirty feet thick: but, arising from circumstances to be hereafter explained, it has lost its uppermost beds. From similar losses, this rock, in many places, is not more than ten or fifteen feet in thickness. On Coombe Down, at the public-house, it appears, by the well, to be four score feet. At Winsley it has been perforated for water to the depth of one hundred and ten feet. At Woolley Hill it has been found one hundred and eleven feet. At the Horse and Jockey, six miles from Bath, in the way to Devizes, we have, as it appears by the well, one hundred and twenty-four feet. At Wormwood House, in the way to Atford, the well is two hundred and forty feet deep, being sunk through the forest marble and the oolite; so that on the whole this stratum cannot be estimated at less than one hundred and forty feet; and its attendant clay, with its fuller's earth, may be considered as not inferior to it in thickness.

It is this clay which is the sliding ground so visible round Bath on all the hangings of the hills. It is every where observable, but is more particularly seen and felt at Coombe Grove, and near the mansion belonging to Captain Candler Brown.

X. THE INFERIOR OOLITE.

The thickness of this rock can be obtained either behind Lansdown Crescent, and Camden Place; under Mount Beacon; at Beechen Cliff, and by Devonshire Buildings; at Mitford, and in the course of the canal; in all which places it is about forty feet thick, and its subjacent sand is no where much less, so that the whole of this calcareous stratum, near Bath, is about four-score feet: but West of Mount Beacon, the sand alone is eighty-two feet, as appears in the well at American Buildings. Its bed of blue marl and clay is usually about sixty or seventy feet. At Caroline Buildings, to the South of Bathwick, the well was sunk ninety feet, all in clay and marl. At Bath Easton it appears to be of much greater thickness.

XI. THE LYAS.

This stratum at Twiverton appears to have been laid open to the depth of about twenty feet. But they have taken only the blue beds, under which comes blue clay, four feet, covering numerous beds of white lyas. To the West of Twiverton quarries, the ground rises rapidly, and white lyas appears incumbent on the blue. In the inferior beds of white lyas, at Twiverton Mill, they have sunk twenty-three feet for water, and at Puckle-Church Collieries their pits have penetrated through sixty feet of lyas; yet here they want some of the superior beds, which appear at Bath Easton.

Under the lyas we have fifteen feet of blue marl, in the first coal pit West of Twiverton; and at Bath Easton this marl bed is twenty-four feet.

XII. THE RED GROUND.

The red ground, including its marl beds, grit rocks, mill-stone, and pennant flag-stone, has been found above the coal of various thickness, from one hundred to one hundred and four-score feet, or even more. At Puckle-Church it measures one hundred and fifty-three. Under this, in the above-mentioned district, they meet with *duns*, that is, an argillaceous rock, called Thon by German miners. Beneath these are found a rock, called white stone, then slate and veins of coal, of various thickness, under which they have met with red ground again, and although they have sunk one hundred and eight feet in it, they have not yet got through it.

In what I have hitherto advanced, it must be understood that I do not speak with absolute precision, for more minute investigation will undoubtedly discover local irregularities, such however as may be easily accounted for, when I shall proceed to consider the accidents to which all the fore-mentioned strata have been subject.

Beyond the limits I have traced, it is not easy to ascertain the thickness of the several strata which remain hereafter to be noticed. First, because being hard, they have not, to the same degree as the preceding strata, been subject to attrition. Secondly, because the spirit of adventure, on which deep perforations must depend, has been chiefly confined to districts, where either coal strata or the precious metals have been found.

XIII. METALLIFEROUS LIME-STONE.

In Derbyshire, the great mass of lime-stone is separated into four beds by intervening beds of toad-stone. These beds differ in their properties, but, considered as one mass, the three uppermost beds together measure four-score fathom, and the fourth, as I apprehend, is of uncertain thickness. The beds of toad-stone are of various thickness; the first eight fathom, the second twenty-three, and the third eleven. At least these are the dimensions in one pit.

In some of the lead mines the whole has been covered by sixty fathom of mill-stone, grit, and as many of a black slaty substance.

In Somersetshire it is difficult to ascertain the regular thickness of the lime-stone beds.

DIP OF THE STRATA.

TILL we arrive at the mountain lime-stone, the regular dip of the superior strata is to the South East, which is the prevailing dip in almost every part of Europe. The coal strata dip in every possible direction; and beyond them, in proceeding Westward, the schistous strata either dip to the North West, or rise up in a direction almost perpendicular to the horizon.

That the natural dip of the superior strata is to the South East may be seen by our *chalk* hills; because, from the elevated district in which the Kennet and the Hampshire Avon rise, they sink in that direction, till at Chichester they are lost in the English channel. But even in the channel, chalk is found by the plumb line, and by anchorage. The dip of the *red sand* and quern stone appears in the descent from Lockswell Heath to Sandy Lane, which is all the way on its *back*, that is on the upper surface of the stratum. In proceeding South East from Atford to Stapleton, from Kingsdown and Wraxal to Trowbridge, from Philips Norton to Woolverton, or from Box Hill and Corsham to Chippenham, we descend on the back of the *corn brash*.

The natural dip of the *great oolite* appears in looking down from Petty France towards Calne, or still more clearly by descending on its back, either from Lord Digby's Park towards Dorchester, or from Winsley to Bradford, a little beyond which it sinks under ground, as may be distinctly observed in the Kennet and Avon Canal, by Grip Wood, and a little Eastward of the Wharf, beyond which, to the South East, it appears no more.

The dip of the *bastard free-stone* is evident in looking from the top of Dundry Hill, near Bristol, where the whole rock is found, to Limply Stoke, and to the Avon, a little to the West of Bradford, where it sinks out of sight.

Should we trace an imaginary plane from the quarries at Keynsham, from Cotham Hill, or from Kingsdown and Stapleton, near Bristol, to the bed of the Avon, near the Old Bridge, in Bath, where the *lyas* beds sink to appear no more, we should have distinctly the dip of these beds, and perceive that, like all the superincumbent strata, they incline towards the South East.

But to be more accurate in our calculations, we must have recourse to such measurements as we are able to obtain.

TO BEGIN WITH CHALK.

From the hills in which the Rivers Kennet and two of the Avons rise, to Chichester, a distance of sixty miles, the fall is nearly six hundred feet, that is, ten feet in a mile. But as the district in which these rivers rise does not contain the superior beds of *chalk*, and as at Chichester the inferior beds sink down beneath the tide, it is evident that the stratum of chalk *dips* much faster than ten feet, perhaps not less than fifteen or twenty feet in a mile.

The high road from Bath to London ascends the chalk hills two miles to the East of Devizes, and from Beckhampton proceeds along the vale, through which the Kennet glides, to Marlborough, where it climbs the hills, leaving the vale at a considerable distance to the North, and proceeds on the back of the chalk hills to Froxfield. There it enters the vale again, and follows the course of the Kennet, by Hungerford, to Newbury and Reading, inclosed by distant hills of chalk, till it passes by the chalk cliffs of Clievedon. From Maidenhead Bridge the vale expands, still bounded by distant hills of chalk, and having a sub-stratum of chalk covered by alluvial gravel.

Now as near Devizes the chalk hills rise more than a thousand feet above the low water mark at London Bridge, the dip in this direction cannot be less than the preceding calculation makes it.

In Essex, the dip towards the Thames appears to be abundantly more rapid. In the Northern part of the county, the chalk forms hills, as on Chisall Common, at Norton End, Saffron Walden, Hadstock, Hempsted, and Steeple Bumpstead; but Southward it appears only in the ditches, as at Thaxted. At Dunmow it lies still deeper, and at Chelmsford its rubble may be seen with marl under and over thick beds of clay. My much lamented friend Dr. Menish, informed me, that at the new barracks, near Chelmsford, the wells are sunk through clay three hundred feet. According to him, at East Haningfield, the well is four hundred and seventy-five feet deep; at South

Haningfield, four hundred and twenty; at Purley, Lachington, and Mayland, about three hundred and fifty. The same is the depth at Hullbridge. Near the margin of the Thames, the wells run over. At Sheerness the well is three hundred and thirty feet. Yet not one of them discovers the subjacent chalk, because they no sooner approach this stratum, than water gushes up in great abundance.

The *grey sand*, on which Devizes stands, is four hundred and twenty-six feet above low water mark at London Bridge. Over the grey sand we have about sixty feet of green sand, which comes immediately under the chalk. But near Guildford, in Surrey, which is one hundred and fifteen feet above low water mark, the sand appears running under the chalk. The distance is sixty miles, consequently the dip appears to be six feet in a mile. But here it must be noticed that our line of direction is not S. E.

That bed of the *great oolite*, which we find behind Prior Park, is said to be five hundred and forty-five feet above low water mark at London Bridge; but Farley Down is seven hundred feet, and Lansdown eight hundred and thirteen, by the measurement of Mudge. As, however, on Lansdown, about sixty-five feet are wanting to complete this stratum, its regular summit may be considered as eight hundred and seventy-eight feet; from which, if we deduct the level of Bradford, (being, as Mr. Rennie informs me, one hundred and twenty-six feet above the low water mark) and state the distance at seven miles, the whole dip will be no less than one hundred and eight feet in a mile, which is, in fact, the dip from Lansdown to Farley Down.

The reason for this discordance in the dip of the several strata in different distances and districts, may be found, partly in the inequality of their thickness, and partly in circumstances which will be hereafter noticed. One thing, however, is already clear, that the natural dip of the superior strata is to the South East.

In the Isle of Wight the dip is reversed. All the high hills are chalk, and continue to the back of the island, where their fragments, with those of the subjacent rock, have formed a terrace, which rises more than five hundred feet above the level of the sea, and stretches along the shore for a considerable way. Above this, a cliff of sand rock rises two hundred and forty-three feet, with strata dipping to the North. The great chalk range which extends from Farnham to Dover and Folkstone, dips very fast to the North, but the South Down range dips towards the South, with a gentle declivity.

Our *mountain lime-stone* is not so regular in its dip. At Wick, near Bath, it dips N. W. 45°, but in Wales, from Caerphilly Castle to Aberavon, it dips in the same angle to the North; and from Narbeth, Eastward, it appears to dip South, about one foot in ten.

Its general dip in Europe has been conceived to be N. W. but this must depend on the situation of the granitic chains.

Wherever it appears near granite, it is much elevated, or becomes almost vertical, but in proportion as it increases its distance from the granite, it approaches nearer to an horizontal line. In Rosilly Bay, at the extreme point of Glamorganshire, particularly in Wormshead, we see, when the tide is out, the beds of lime-stone dip in opposite directions, some to the North, others to the South, and some are perpendicular.

Coal, following the direction of the mountain lime-stone, dips at Newcastle, mostly to the East, and at Whitehaven to the West, about one foot in twenty. Near the sea coast, and in the interior of the country, it dips in every direction. This circumstance will be more particularly noticed in the progress of my work.

Schist, in England and in a considerable part of Europe, dips N. W. As it approaches granite, it becomes almost vertical, but, when distant from granite, it may be nearly horizontal. This becomes palpable in Alpine regions, in which the granitic chain rises majestically, supported by secondary strata.

The *Ural* mountains, extending from N. E. to S. W. through the vast extent of more than thirteen hundred miles, contain, as we have seen, granite, schist, lime-stone, and chalk. One side of this chain presents a very extensive plain, verging Westward by an easy descent, and falling either to the North into the White and Frozen Ocean, or to the South, in the direction of the Volga, into the sandy deserts, between the Caspian and the Sea of Azof. Siberia, which is to the East of the Ural Mountains, declines gently towards the Glacial Sea, and rises South by imperceptible degrees, till it forms the stupendous range of Tartarian mountains, which separate the Russian and Chinese Empires.*

In South America, the rivers shew the dip of the country to be toward the East.

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* Plescheef's Survey of the R. E.

The Western coast has deep seas, granitic mountains, numerous islands and sunken rocks. At a short distance from the shore, there are no soundings, and the adjacent mountains are the highest in the world. But the Eastern coast is flat, the shore sandy, and the sea gradually deepens about one fathom in three miles.

The same precisely may be said of Indostan, because the granitic chain, with deep water, forms the Western limits, and the great rivers run towards the East, where they have shallow water, and no natural harbours.

Wherever the granitic chain is central, as in the European Alps, all strata recline against it, consequently dip in opposite directions.

It seldom happens, that the natural dip of granite can be discovered, because we have few excavations in it. But at St. Roch, on the Italian side of the Alps, is a little mountain, three hundred feet high, in which the strata are all horizontal granite. It has eight distinct beds, the bottom one of sixty feet thick, the next fifty, the third twenty, then in succession five strata of forty, twenty, forty, ten, forty. In the bottom bed is a stratum of white field spar, half an inch thick, running parallel to the other strata. The surrounding mountains have the same horizontal strata of granite.*

Again from Cresciano to Giornico, and far beyond it, the granite appears in horizontal beds. *Monte Rosa*, which is two thousand four hundred and thirty toises, or more than fifteen thousand seven hundred and twenty feet above the level of the sea, and commands the Southern, as Mont Blanc does the Northern Alps, is throughout veined *granite*, *stratified*, even to the summit, and is either perfectly horizontal, or nearly so, dipping a little to the North.*

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* Saussure, § 1752.

The highest granitic rocks are, however, composed of pyramids, arranged against each other, mostly in a vertical position through the whole extent in the centre of each chain. These are supported by other pyramids which lean against them.

For this information respecting the Alpine granite, we are indebted to Saussure's inestimable work.

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* Saussure, § 2116.

OF THE RANGE AND EXTENT OF THE STRATA.

HAVING ascertained the order and succession, with the thickness and the dip of the several strata, let us now take a survey of their direction and extent.

From the circumstance of the dip being to the S. E. it follows, that the range or direction, as discovered by the horizontal section, must be N. E. and S. W. and such is really the case through England, Wales, and Scotland, as appears evidently on the best maps, by our mountains, by our vallies, by the Northern lakes, by our principal rivers, and by the Western range of islands. In our mining countries the same range is manifested, by the veins of tin and copper. Through Spain, Portugal, and France, and throughout the greatest part of Europe, Asia, Africa, and America, the same is said to be the direction of their mines.

I. CHALK.

Chalk occupies the high ground in the contiguous parts of Dorsetshire, Wilts, Berks, Bucks, Bedfordshire, Cambridgeshire, and Norfolk, stretching from Wedworthy and Membury, Axmouth, Chard, White Down, Crewkerne, Castle Cary, and Beaminster, its Western boundary, in a waving line, by Traveller's Rest, Dorchester, Warminster, Roundaway Hill, near Devizes, Cherhill, near Calne, the high lands South of Swindon, and Wantage, by Henley, Dunstable, Baldock, Mildenhall, Brandon, and Royston, to Burnham Market in Norfolk, Horn Castle, and North Willingham, and the mouth of the Humber. It proceeds by Beverley, and terminates on the sea shore at Flamborough.

To the N. W. of this line no chalk appears. But when we trace it from near Axmouth and Chard, on the Southern coast, we find it running by Asker's Well, Dorchester, Wareham, (which has only the hard bed) Eucomb Bay, and Corfe Castle; and although it is there interrupted by the sea, we meet with it again at the Needles, where the cliffs are six hundred and fifty feet high, and follow it over Afton Down, Gatecomb, Arreton Down, Brading, St. Helen's, and Culver Cliff, at the Eastern extremity of the Isle of Wight. It, in like manner, stretches from Portsmouth, by Chichester, round the coast.

This range of chalk is interrupted by deep vallies, in which the sand bed appears attended by alluvial strata.

Within these limits we remark three principal ridges, which stretch themselves through the interior of our chalky region.

The first, leaving Berks, runs North through Bucks, Bedfordshire, and Hertfordshire, into Cambridgeshire, by Dunstable, Hitching, Baldock, and Royston, to Gogmagog Hills, near Cambridge.

The second, leaving Berks, stretches Eastward through Surrey, where it forms the Hogsback, that beautiful ridge which extends from Farnham to Guildford, and it then appears at Boxhill. This branch forms the hilly country and the downs North of Ryegate, Bletchingley, and Godstone, then enters Kent to the North of Westerham, and goes by Riverhead to Wrotham, where it takes to the South of Dartford and Rochester, and passes by Lenham and Canterbury to Folkstone and Dover. One division of this ridge is continued on the North coast of Kent, by Feversham, near Sheppy, Margate, and North Foreland, to Ramsgate. It is very remarkable, that South of this line, it leaves the sand bed exposed to view. Thus, for instance, at Guildford we have high chalk cliffs, and South of these we see sand hills rising up from under the chalk, and extending Southward all the way to Petersfield, where it meets the third ridge of chalk.

The third ridge leaving Wilts and Berks, enters Hants, and to the South passes round Petersfield; then stretching to the East, forms a barrier against the sea along the coast from Chichester and the South Downs, as far as Dover; or ranges from Maple Durham, Houghton, Steyning, and Lewes, as far as Beachy Head.

But although the continuous mass of chalk is confined to the fore-mentioned limits, we trace it, in detached portions, at Purfleet and at Saffron Walden in Essex, on the North coast of Norfolk, and thence round the coast, proceeding to the East as far as *Walsham.*

Thus chalk hills are found to occupy the South East corner of our island, bounded by a line which stretches from South West to North East.

But even where no chalk appears upon the surface, it forms the substratum through a vast extent of country. Thus on its Northern limits, at Ridlington, in Rutlandshire, and Stukeley, in Huntingdonshire, it has been brought to light. And from Hungerford to Reading, and thence to London, or to Bagshot Heath and Windsor Forest, it appears in depth; and along the banks of the Thames, in Essex, it is found some hundred feet beneath the surface of the alluvial strata.

This description appears to be minute; but it is meant only as a general survey.

II. THE SAND.

Sand every where appears in the low lands of the districts which are occupied by chalk; and may be traced all the way from Twiverton, by Sidmouth, Blackdown, Honiton, Axminster, Lyme Regis, and Charmouth; Crewkerne, Bridport, Cerne Abbas, Hindon, Tisbury, and Fonthill; Longleat, Horningsham, Bradley Knoll, Seend, Chitty, and Lockswell Heaths; Farringdon, Highworth, Mixbury, and North of Wooburn, Amthill, Southill, and Sandy; Northampton, Mears Ashby, Brixworth, Desborough, Kettering, Rockingham, and Peterborough, to Lynn, in Norfolk, where it meets the sea.

It is seen likewise in the Isle of Wight, in Sussex, and in Surrey, as an attendant on the chalk. It is rendered conspicuous by its heaths, but more especially by its iron ore, and vast heaps of scoriæ left by the rude inhabitants of former times. High mounds of these appear in Rockingham Forest, and it may be particularly noticed, that throughout the whole extent of country I have mentioned, wood and iron stone, the fuel and the metal to be fused, meet together.

I have already noticed the *fire stone* beds of the grey sand at Meerstham. The same beds are wrought at Beer in Dorsetshire, at Totternhoe in Bedfordshire, and, although not to so great an extent, at Compton, near Calne. They have likewise been resorted to near Wootton Basset.

One of the grey sand beds which supplies England with whetstones, has been principally noticed in Blackdown, where numerous quarries extend, by wide horizontal drifts, near three hundred yards into the hill. The same bed has been noticed on Bradley Knoll, and in the hills above Sidmouth. This valuable bed, if sought after, would be every where found under chalk. Other beds have, in various districts, been equally concealed. At Swindon we have, as above described, considerable beds of lime-stone, precisely the same as at Wheatly and Brill near Oxford, at Ailesbury, at Fonthill, and in Portland: in all which places the rock may be distinguished, and its identity ascertained by its peculiar fossils.

Yet in other places, where we might expect to find it, our researches have been vain.

Portland seems to contain the same beds as have been found at Swindon, because, as I am informed, under the soil they have—1. Stone brash; 2. Coarse free-stone; 3. Fossil shells; 4. Fine free-stone, or calcareous grit.

III. THE SUPERIOR OOLITE.

I have myself traced this valuable rock in few places.

It is found at Swanwich, Steeple Ashton, Bowood Park, Spy Park, Calne, Chilmark, Highworth, and Shotover near Oxford, where extensive quarries yield the stone of which the colleges and other public edifices are built.

I apprehend, this must be the lime-stone noticed by M. de Luc in the third volume of his Geological Travels, page 39, where he is describing Portland, and pages 63 and 201, where he relates his journey from Weymouth to Dorchester.

Unless covered by the spoil of superior strata, this rock must be traceable in a direction N. E. and S. W. through its whole extent, and may be sought for to the N. W. of the *chalk* range. Judging thus by its position, I am inclined to think that the calcareous rock at Waldick, Litton, and Long Bredey in Dorsetshire, belongs to it. In the Eastern part of the Isle of Wight is a calcareous rock, which, from recollection, I conceive may be, as reported, the superior oolite. But should it be found above the chalk, and contain turbinated shells, there will be reason to suspect it may be the same rock which is in the vicinity of Paris.

IV. THE CALCAREOUS GRIT.

This appears at Seend, at Westbrook, at Spy Park, at Derry Hill, and West of Calne. Beyond these limits I have not traced it, because I have not conceived it to be worthy of particular attention. It no doubt preserves its place, and therefore may be easily discovered between the superior oolite and the coral rag.

V. THE CORAL RAG.

The coral rag has been traced from near Heywood, Westbury, and Steeple Ashton, to Bromham, Calne, Quemmerford, Hillmartin, Goat Acre, Lyneham, Tockingham, Wootton Basset, Lydiard Trygoze, Stratton St. Margaret's, Marston, Shrivenham, Higworth, Faringdon, Bibery, Burford, Ensham Hill, Under Shotover Hill, and Bullington near Oxford; at Clipston, Cosgrave, Desborough, Towcester, and through the midst of Northamptonshire, to the sea side North of Lynn.

The marl and clay attendant on this stratum form a very poor tract of country, in many places abandoned to forests and commons, yet with some considerable mixture of arable and pasture land, which traverses the kingdom.

In it is found fossil wood, charred into a species of coal, which, with the containing bed, may be traced from Lyme to Marston Moor, Gillingham, Mere and Witham Friary, Frome, Selwood Forest, Standerwich Common, Westbury Common, North Bradley Common, Road Common, Steeple Ashton, Melksham Forest, Brumham Common, Bewley Common, Pewsham Forest, Chippenham, Titherington and Stockham Marshes, Bredon Forest near Malmsbury, Bampton-in-the-Bush, New Common, Witchwood Forest, North Leach Heath, Woodstock, Otmoor, Wadden Chace, all through Bedfordshire, and, as I conceive, through Huntingdonshire and Lincolnshire Fens, which terminate in Boston water, between Boston and Lynn.

VI. THE KELLOWAY ROCK.

This rock has been distinctly traced from Bruham Lodge to Witham Friary, Marston Bigott, Road Common, Lady Down, Trowbridge, Steeple Ashton, the bis aqueduct on the Kennet and Avon Canal, Hinton Moor, the high ground between Trowbridge and Semington, Chippenham, Titherton, Kelloway Bridge, Brinkworth Common, Blick's Hill near Malmsbury, Cumner Hill, and all the highest hills in Oxford and Northampton shires.

VII. THE CORN BRASH.

We have been so fortunate as to detect this stratum from Henstridge, Temple Combe, Horsington, Rockhill, Lattiford Mill, Wincanton, Seale's Green, Mells Parish, Laverton, Woolverton, Road, and all the high lands from thence to Hinton, Tilsford, Trowle, Trowbridge, Hilperton, Kingsdown, Wraxall, Cottle's Farm, Atford, Semington, Melksham, Corsham, Laycock, Notton, Chippenham, Grittleton, Malmsbury, Norton Mill, Langley, Draycot, and Sutton. It is found on the Northern borders of Oxfordshire, and may be seen at Bicester, Buckingham, and Bedford. It runs through the borders of Northamptonshire in a line, which extends, as I am informed, from Buckingham to Peterborough, in its way to the German Ocean

VIII. THE FOREST MARBLE.

How far this stretches to the South West I have not been able to discover; but it is procured for sale at Stalbridge, Hardington near Mells, and Swanage, and may be seen distinctly in the vicinity of Frome, whence it stretches to Lullington, Laverton, Shawford, and Norton. In this direction it appears on the brow of the hill at Hinton, where Mr. Day has opened a quarry behind his mansion. We meet with it at Farley Castle, Westwood, Burfield, Ashley, Frankley, Wraxal, Stowford, Jaggards near Pickwick, Atford, Allington, East of Castle Coombe, Nettleton near Tedbury, at Througham, on the Cotswold Hills near Cirencester, and Fairford in Oxfordshire, whence, as I am informed, it stretches through the middle of Northamptonshire.

The siliceous sand attendant on this stratum is particularly noticed at Stalbridge, Mells Parish, Hinton, Norton, and Chatley. It is a sub-stratum at Woolverton, and proceeding South it appears at Shawford and Beckington. To the East of this range it has been traced between Winsley, Farley Down, and Wraxall, from whence it is to be seen all the way to Bradford Leigh. This appears to be the free-stone of Morton, which he mentions his having found at Eydon, Litchborough, Harlestone, Desborough, Mears Ashby, and Northampton, because it is near to the genuine free-stone, is angulated, and frets the tool.

IX. THE GREAT OOLITE.

I understand that this rock has been found near Yeovil, Castle Carey, and Bruton. It appears to the South of Sherborne, by Lord Digby's; but, in proceeding from the South West towards Bath, Newberry Hill in Mells Parish, and Timsborough Slade, are the first places in which I have met with it. If we are disposed to trace it from thence; having ascended to the canal under Buckland Down, we shall find its bottom bed laid bare; and passing Phillip's Norton, at Hinton Field Farm, we shall see this rock rising up from under the forest marble. In the same direction, we may trace it to the brow of the hill at Hinton, where it seems to terminate; but, having passed through Mitford, we meet with it again at Mitford Castle, and, after some interruption, see it rising up to occupy another extensive brow from the Cottage Crescent, by Anthony Hill, Combe Down, and Prior Park, to the Eastern margin of Claverton Down.

From the South East it rises up to view at Bradford, where, on the Southern hanging of the town, the whole rock is found. From thence it has been traced, by Winsley, to the Northern edge of Monkton and Farley Down, where its valuable quarries and majestic cliffs attract the eye.

Extensive quarries have been opened on this rock at Box, Bath Ford, Kingsdown Hill, and Pickwick, which is a little to the West of Corsham; at Bradford, Westwood, Stoke, Farley, Coomb Down, and Hampton Down. Lansdown has the bottom beds, which terminate on the Northern hanging of the hill, and it is curious to observe numerous pits remaining near the monument, to remind us of the ignorance which prevailed in former times; because from these very pits, at the distance of four miles from Bath, all the free-stone was taken for building the city and cathedral, although the same kind of stone was immediately at hand, but concealed, till Mr. Allen opened his quarries behind Prior Park.

From Lansdown we trace the same beds on little Salisbury, at Cold Ashton, on Banner Down, at Coldhorn, and further to the North at Marshfield, Castle Combe, Toll Down, Hampton Common, and on the Cotswold Hills.

Beyond this I have not traced it; but, from some specimens which have been sent to me, I collect, that the rocks particularly noticed by Morton in his Northamptonshire, accord with those which are found in the vicinity of Bath. He mentions two species of freestone, one composed of uneven angulated grit, the other composed of spherical white particles, like the ova of fish. The former seems to be our Hinton sand-stone; the latter, our great oolite.

This he found at Kettering, at Pipwell, in Rockingham Forest, Stanion or Stanjan, Weldon, Wakerly, King's Cliff, and at Barneck, Barnack or Barnoak, from whence King Wolfere, A. D. 664, built Peterborough Abbey: here eight pair of oxen were required to move one block. From Barneck quarries were built the Abbeys of Rumsey and St. Edmund's Bury. This rock occupies all the high land between the Welland and the Nyne. The same stone is found at Ketton, in Rutlandshire. In Lincolnshire many churches are built with it; and my friend, Dr. Wilkinson, has favoured me with a specimen from Grimsthorpe.

The attendant calcareous slate of Aynho, Halston Heath, Weston Flavel, Northampton, Brixworth, and Colly Weston, has been picked up by William Smith on Lansdown. In short, this most distinguished geologist has traced the great oolite through Somersetshire, Glocestershire, Oxfordshire, Northamptonshire, Rutlandshire, Lincolnshire, and Yorkshire.

Wherever the great oolite extends, its bed of clay and fullers' earth universally appears, and may be distinguished by the poverty of its soil, approaching, in some districts, to incorrigible barrenness.

In short, this valuable rock may be traced in the direction of the Severn, from S. W. to N. E. through the centre of the kingdom, in the intermediate space between the coal districts and the chalk, but is no where so much exposed, nor so much rent and separated by deep vallies, as in the neighbourhood of Bath.

X. THE INFERIOR OOLITE.

The inferior oolite, or bastard free-stone, appears at Ham Hill, Wincanton, Bayford, Leigh Common, Ilminster, Yeovil, Bruton, Castle Carey, Wincanton, North of Sherborne, at Doulting, two miles East of Shepton Mallet, whence the stone for Wells Cathedral was taken, and on Dundry Hill, near Bristol. Proceeding Eastward, we have it again above Woden's Dyke, on the summit of Stanton Berry Hill. It is seen at Broadfield Down, Murdicomb Bridge, Vallas, Mells, Radstock, Old Ford, Writhlington, Dunkerton, and Inglescomb. To the South of Bath it appears at Mitford. Devonshire Buildings stand on this rock; and about two hundred yards from thence, behind the houses, in the meadow, and on the right hand in the old road to Frome, it is seen distinctly lying on its bed of sand. Freshford stands upon it. To the West of Bradford it is seen rising up, and at Stoke we have it in the canal. To the North of this it appears at Sydney Garden, in the high road to Claverton, Beachen Cliff, Mount Beacon, Lansdown Crescent, East of Camden Place, at Swanswick, Toghill, Cross-Hands, Petty France, Rodborough, and Cheltenham. I understand that it runs through Northamptonshire; but I can venture to say, that between Wantage and Oxford, the high ways are mended with it; in Shropshire the Wrekin is covered by it.

Under the sand of this rock we every where notice blue marl, which forms a very fertile soil.

XI. THE LYAS.

Beds of this valuable lime-stone first attract our notice in the English channel, at Yarcombe, Otterford, Axminster, and Lyme Regis, then at Charmouth.

On the corresponding sea coast, in the Bristol channel, we meet with lyas beds of a different species, carrying different fossils. These are found to the West of Minehead, in Exmore Forest, Polden Hill, and at *Watchet*, which little village has derived its name from their blue colour.

Beds of lyas are found on the Eastern margin of Blackdown, at Chard, Martock, Somerton, Langport, Castle Cary, Brent Knoll, Street, Pilton, Camel Hill, and Glastonbury, where they form the basis of Torr Hill. North of this they are cut off by the Mendip Hills. They are again visible at Banwell, Worle, Congersbury, Long Ashton, and Nailsea, to the West; and at Chewton Mendip, Stone Easton, Kilmersdon, at Radstock, Writhlington, High Littleton, Timsbury, Camerton, Farmborough, Priston, Marksbury, and Stanton Prior, to the East. Near Castle Cary the lyas and the chalk seem to meet.

Near Bath we see them South of the river, at Twiverton, Newton, Chewton, Keynsham, and all the way westward to the vale at the foot of Dundry Hill. North of the river we observe quarries of the same beds at the blue lodge, Weston, Kelweston, Bitton, and a little to the East of Hanham. To the North of Bristol we trace them in Cotham Hill, on the Western limits of Kingswood, and particularly in Mr. Tindal's Park; but returning by the Marshfield road towards Bath, we lose sight of the lyas, and travel on the red ground till we come near to Wick. From thence we may trace these beds to Puckle-Church, Abston, Durham, Deynton, and Tracey Park, near to which, in Beach Lane, we see the lyas resting on the mountain lime-stone.

On the Welsh coast, the Watchet lyas beds appear in the low country from Swansea Bay to Cardiff and Newport. At Aberddaw, they have long since been resorted to for lime-stone of a peculiar quality, as an article of export; and to the marl of this stratum the vale of Glamorgan is indebted for its extreme fertility.

The lyas beds appear at Purton Passage, at Westbury Cliffs, and at May's Moor. Mr. Strange traced them through Gloucestershire, Worcestershire, Warwickshire, and Leicestershire, occupying the lower parts of all these countries.* They have been particularly noticed round Gloucester and Tewksbury, in the vale of Evesham, and at Stonebench, where they form a bar across the Severn. They surround Malvern Hills; they appear both at Dudley in Staffordshire, in Colebrook Dale, the North of Leicestershire, and the South of Nottinghamshire, and after proceeding in this direction through Yorkshire, they go into the sea at Tynemouth. Blue marl attends these beds, and contributes to fertilize the extensive districts over which it spreads.

We thus trace this readily to be distinguished stratum in a direction from S. W. to N. E. across our island from sea to sea.

XII. THE RED GROUND.

The red ground is one of the most remarkable features in our island. It meets the eye in Torbay, a little to the South of Paynton and Babicomb Bay. From hence, proceeding to the North East, it shews itself in the country round Exeter, Crediton, Cullumpton, Taunton, West Sedge Moor, Burton Pincent, Bridgewater, Axbridge, Brislington, Bristol, Kingswood, and Marshfield. It is seen in South Wales, and follows the Brecknock canal throughout its whole extent. The Usk runs in it. Indeed all the rivers, brooks, and ravines in Monmouthshire, discover the same martial earth. The Severn takes this stratum for its bed. It covers the forest of Dean, and stretches over the counties of Hereford, Worcester, Warwick, Salop, Stafford, Leicester, Nottingham, Derby, Chester, Lancaster, the West Riding of Yorkshire, Durham, and Newcastle.

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* Archaiologia, VI. 37.

In North Cheshire all the towns, and most of the villages, are built with the stone of this extensive stratum; a stratum which, in Exeter, gives name to Rougemont Castle, now a prison; in Somersetshire, to Radford, Red Hill, and Red Cliff; in Gloucestershire, to Redbrook; in Worcestershire, on the borders of Gloucestershire, to Red Marly; in Warwickshire, to Radford; in Nottinghamshire, to Retford, Radford, Ratcliffe, and to Red Hill, at the junction of the Trent and Toar; in Derbyshire, to Retford; and in Yorkshire, to Rotheram, Red Mire, Red Ho, and Red Car Rocks, which appear on the sea coast between Gisborough and Hartepool.

Throughout the whole of this range, we find some of the richest land in England, consisting of red marl, which is every where most fertile for wheat, barley, beans, peas, and is equally distinguished for the goodness of its cider.

The red ground contains marl, which is composed principally of lime, clay, sand, and carbonate of iron. It contains likewise extensive beds of grit, and mill-stone, that is, lime-stone breccia or pudding-stone, and micaceous sand-stone, which is a silicious schist with a ferro-argillaceous cement, and which breaks into rhomboidal fragments. This, about Bath and Bristol, is known by the name of *pennant stone.* We remark in the rock considerable veins of quartzose pudding, with a martial and silicious cement, as may be particularly noticed in Brandon Hill, Kingsdown, Coal Pit Heath, and at Wick, in the lane leading from thence to Deynton. From the chasms of the mill-stone, or pudding bed, much calamine has been procured in Mendip.

In Cheshire, as in other parts of the globe, this stratum incloses gypsum and vast beds of rock salt, either on mountain summits or in the deepest mines, as at Durenburg, where it is one thousand three hundred and twenty feet below the surface.

The uppermost beds of the red ground inclose sulphat of strontian in considerable quantities, as appears on Corston Hill and Leigh Down, at Aust, Cook's Folly, Kingswood, Stapleton, Ham Green, Puckle-Church, Wick, Sodbury, and Wickwar, where it is found both stratified and in veins.

In the rivers, the red ground, as we have seen above, forms numerous fords.

XIII. COAL.

It has been observed, that a line drawn from S. W. to N. E. through Leigh under Mendip, to Sunderland, and another parallel to it from Tenby, in Wales, to Baldoc, in Scotland, inclosing a tract of country one hundred and ten miles wide, and three hundred long, will contain the great coal range of our island. These lines, however, must be curved so as to take in Warwickshire, which abounds with coal.

Our coal does not form a continuous stratum, but is confined to *fields*, shut in by mountain lime-stone, which, in each field, forms an elliptical basin. Let us then trace some of these.

In *South Wales* the coal beds first appear, proceeding from St. Bride's Bay, in Pembrokeshire, a little to the South of Haverford West and Narberth; whence, passing within five miles of Caermarthen, they cross the Swansea Vale between Bettws and Pont y Dillys, and the Neath Vale, near Abernant; from whence they go to Cyfartha and Dowlais, thus surrounding Merthyr, and proceed by Syrhowy and Beauford to Clydach; after which, keeping the summit of the mountain opposite Abergavenny, they turn South to Blaenfon and Ponty Pool. Beyond this they run into the hill, on which stands Pentwm Barlwm; and passing West, near Caerphilly, they cross the high road about five miles North of Cardiff. Hence they proceed by Llantrisant, Bridgend, Margam, Aberavon, Britton Ferry, and through the Swansea and Caermarthen Bays to Tenby.

This coal has an argillaceous roof, now called dons, formerly doon stone, and in German, *Thon;* over which is a micaceous sand-stone, called pennant-stone. The floor is of the same nature with the roof.

Within this extensive and elliptical inclosure, we have one similar to it, but much smaller, which begins in Caermarthen Bay, and has collieries established on it at Kidwelly and Llanelly; from whence it crosses the Swansea and Neath canals, appears below the junction of the Aberdare and Merthyr Vallies, goes to Bedwelty and to Llanhithel on the Monmouthshire canal, where it turns to the South, then to the West, by Neath and Swansea, where my father was the first who laid open these extensive collieries.

This coal, like the preceding, has an argillaceous roof, covered by micaceous sand-stone. In this interior ellipsis we have more than twenty coal beds, all which dip, throughout their whole extent, towards one common centre.

It is worthy of our notice, that in this coal field we have two distinct species of coal.

In the outer range, as far East from Tenby, as Aberpergwm, and from Abernant to Merthyr, we find stone coal. The interior range, far from the mountain lime-stone, has principally melting coal; but at Kidwelly, where it lies on lime-stone, it becomes stone coal. These differ exceedingly in quality. Such facts are worthy of attention. Stone coal is infusible, and burns without either flame or smoak, and does not soil the hands. It gives an equable heat, and therefore it is fit for malting, and for the smelting furnace.

Melting coal, as the name implies, is fusible, and cakes. It smokes, soils the hands, and augments its heat by flame. It abounds with bitumen, as the stone coal does with carbon.

Whitehaven coal contains fifty-seven parts in one hundred, of carbon; Newcastle coal, fifty-eight; Swansea coal, seventy-three; Cannel coal, seventy-five; and Kilkenny coal, ninety-seven. The coal of

Turditino, on the continent, contains twenty-five; of Mocaïo, thirty-two; of Corlotta, forty-five; of Macinaia, sixty; of Halles, eighty-six: In all these the residue, to complete the one hundred parts, is chiefly bitumen.

In the *Forest of Dean*, the coal field extends from the lime-stone hills of Chepstow and Penhow Castle to the Severn. To the North East, it stretches as far as Lidney, Breeme, Colford, Beacon Hill, and Moseley Green, and has seventeen coal beds, which, together, contain thirty-seven feet in thickness of clean coal, unmolested by water.

The *Gloucestershire and Somersetshire* coal district conforms itself to the mountain lime-stone, by which it is inclosed. But this extensive district, which will be particularly traced when I proceed to treat of the mountain lime-stone, has many coal fields, which require a separate consideration.

I. The most distinct and best defined of these is in *Gloucestershire*, on the Northern range, round Puckle-Church. This consists of two ellipses, as in South Wales, external and internal, which are nearly concentric. The external ellipsis may be considered as beginning at Iron Acton, and passing through Wapley and Mangotsfield to Frompton, and then back to Iron Acton. The internal begins between Acton and May's Hill, passes through Westerleigh, Short Wood, near Puckle-Church, and Coal Pit Heath, to the point from which we started.

In the external range the coal is not so considerable as in the internal. The beds are numerous, but small. Yet even in the external range, at Siston, one out of ten coal beds discovered in sinking four-score fathom, is three feet in thickness. All these are separated by either argillaceous or siliceous strata, and all dip towards one common centre, but flatten as they descend, so as to assume not a conical form, but that of a wide bowl dish.

II. In *Somersetshire* the coal district is distinctly bounded to the South by the lime-stone of Mendip Hills, near to which the general dip of the coal beds is to the North, whilst the surface of the country dips South and South East. On the Northern limits of this coal field, the beds dip South.

Near to this elevated ridge of lime-stone, the coal beds are numerous.

No fewer than forty-six appear on *Stratton* Common, all workable, beside many others of inconsiderable value. At Bishop's Sutton they have three remarkable coal mines.

1. The Stinking Bed is two feet thick.

2. About six fathom under this, is the Cathead Vein, so called because it contains incombustible lumps.

3. About six fathom under this is the Three Coal Bed, consisting of three distinct seams, each of about twelve inches in thickness. Under these at regular depths they have other beds, all well distinguished from each other. Now as the same beds are found at Farrington, at the distance of four miles to the S. E. in the direction of their dip, they ought, if the same dip continued, to have been found more than two thousand yards deeper in the latter place than in the former.

But instead of this inequality, they have precisely the same depth. This circumstance Mr. Strachey, A. D. 1727, accounted for, by supposing a fault or trap, of a most enormous magnitude, to have intervened. But the more natural supposition is, that the centre of the coal field is between Sutton and Farrington, because round this point the dip varies rapidly and frequently, and therefore distant collieries established on the same coal beds, if equally distant from the common centre, may be precisely at the same depth.

III. Between the wide extremes of these Glocestershire collieries and those of Mendip we have others, whose limits are not well defined, at Radstock, Camerton, Newton, Hanham, Bedminster, and Kingswood, in which the beds dip in every possible direction. These last are separated by deep vallies, and are covered by the red ground; but although in the deepest of these mines they have sunk one hundred and twenty fathom, they have not penetrated to the mountain lime-stone.

IV. To the West of these collieries we have another coal field, at Nailsea and Kenn, bounded to the North by the lime-stone rocks of Clevedon, Wraxal, and Belmont; to the East by those of Backwell; and to the South by those of Chelvy and Brockley. To the West it is either wanting or dips into the sea. Here the lime-stone forms a beautiful basin, and the coal beds dip towards one common centre, which must be under the Severn, in the Bristol channel. They have here already discovered ten seams, and when the canal shall be finished to Morgan's Pill, the whole of Wiltshire and Berkshire will be supplied with coal from hence.

In *Cornwall*, if there is a coal field, it must be under the sea, in the widely extended bay to the West of Plymouth, shut in by the mountain lime-stone.

Shropshire abounds with coal, more especially on the borders of Staffordshire.

In the parish of Madeley, eighty-six seams of coal have been discovered, of which the uppermost is not deeper than forty-eight feet, and the deepest is said to be seven hundred and twenty-nine feet.

A remarkable coal field is to be seen on Cleo Hill, between Ludlow and Bridgenorth. It is two miles in diameter, and completely surrounds the summit of the hill, dipping every way towards one central point. It beds on argil, under which is silicious sand and pudding-stone. In these collieries they sink ten yards through sand-stone, and sixty-four through basalt; and at the depth of fifty fathom they find the six feet seam of coal. In a colliery to the N. E. of these collieries, the same six feet seam appears; and here, at the very outset, they sink forty-eight yards through basalt.

In *Staffordshire* the upper beds of coal, contiguous, and together not less than ten yards in thickness, extend from Bilstone to Brettel Lane, Amblecott, and the Lye, near Stourbridge, in a district seven miles long and four wide, bounded by two ranges of hills, called Dudley and Rowley. North of this district are other thinner beds of coal, rising up to day from under the former beds, and, like them, governed in their dip by that of the nearest lime-stone hills. And here it must be observed, that the range of mountains extending from Dudley towards Woolverton is formed by lime-stone, whose beds are elevated to a high pitch on each side, so as to form a ridge. In like manner, the coal to the East and West rises up on both sides in a direction corresponding with the lime-stone, which, as well as its attendant coal, is steeper to the West than to the East. But on the Northern extremity of this range, the lime-stone is elevated only on the East side; and the coal to the West is so deep as not to be within the reach of miners.*

In *Leicestershire* the coal seems to be in a detached district; at least we cannot easily connect it with the great line of coal which may be traced through the Northern counties. It is found in the townships of Coleorton, Swannington, Oakthorp, Measham, Dunnisthorp, Askley Wolds, and numerous other townships.

In *Nottinghamshire* the coal district occupies only the Western limits of the county, having the red ground to the South and to the East. Two beds of hard coal are wrought, and each of these is attended by a bed of soft coal. They run parallel, or nearly so.

The Easternmost hard coal bed is about five feet thick, and to the South is found at Linton, near Nottingham, near to which it meets with two great faults; but Northward it goes through the townships of Wollaton, Bilborough, Nuthal, Griesly, and Selston, beyond which it enters *Derbyshire.*

The other bed of hard coal is about a mile Westward of the former, and is from two to four feet thick. It runs parallel to the former, through the townships of Trowel, Strelley, and Cossal, whence it takes the direction of the Erewash toward Eastwood, where it meets with some interruption, but is found again near Oldercar Hall. From hence it continues Northward in the direction of the Erewash, through Codnor Park to Pentridge, where apparently it ends.

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* Shaw's Staffordshire.

A little more to the West is a third bed of hard coal, wholly confined to *Derbyshire*, and attended by a bed of soft coal, which runs parallel to the former. It begins in the South between Kirkhallam and West Hallam, and goes from thence through Shipley, Heanor, Denby, Ripley, and Alfreton; where it meets with some interruption by the fault which extends from Allestry to South Anston.

The principal soft coal beds are about four feet thick, and have been worked, but not so extensively as the hard coal, being employed chiefly for making coke. But many beds, both above and below the hard coal, being less considerable either in thickness or in goodness, have been neglected.

This coal district which appears to the North East of Derby, at Stanton and Morley, runs on to the West of Morley and Belper, appears again at Lea, Ashover, and Dronfield, and extends itself into *Yorkshire*, where it forms part of the great Northern Rake, being only interrupted by a *lime-stone* bed of three miles in breadth, near Ferrybridge. But, for the best account of this coal field, we must refer to Mr. Farey.

Cheshire is principally celebrated for its cheese and for its salt mines, which are well described in the first volume of the Geological Society. But in the North West part of the county we find coal, which probably belongs to an extensive coal field extending into

Flintshire, where the coal beds, bounded to the West by mountain lime-stone, dip about two feet in seven East, towards the River Dee.

Flintshire has coal at Halkin, Flint, Nortrop, Wrexham, Stockport, Disley, Northwich, Macclesfield, and Congleton.

Lancashire contains coal to the South of Preston, and of a line, which from thence runs North East, in the direction of the River Ribble, being principally worked in the hundreds of West Derby, Salford, and Blackburn. Oldham, near Manchester, has considerable beds, some six feet thick, dipping S. S. W. two feet in eleven.

Yorkshire receives in its West Riding, the beds of coal which we have traced in the Western limits of Nottinghamshire, and the Eastern districts of Derbyshire. These, however, are considerably altered in thickness and in quality. The most Eastern beds extend in the direction of Rotherham, Wakefield, and Leeds; and the Western beds in that of Sheffield and Rotherham.

Westmoreland has coal only in the South East part of the county.

Cumberland abounds with coal near to many of its Eastern mountains, and in various districts between Sebergham and Whitehaven, from whence the collieries proceed along the coast by Cockermouth to Maryport, forming a district of about one hundred square miles, in which three coal fields are particularly noticed.

1. Howgill, West of Whitehaven, two miles and a half wide, from the rivulet called Pow, on the Eastern side, to more than one thousand yards under the sea. In this seven beds have been worked.

2. Whingill, N. E. of Whitehaven, extends three thousand yards in length, by two thousand eight hundred in width. The beds are

from four to ten feet in thickness, and dip one yard in ten. In the depth of one hundred and sixty-five fathom they work seven large beds, and have noticed eighteen thin ones. The faults are about one hundred and twenty feet, up or down, and run from East to West.

3. Beside these, a more extensive coal field has been discovered to the South and S. W. of Whitehaven, which is yet unexplored.*

At Preston How, S. W. of Whitehaven, on the Croft Pit, they cut fourteen beds of coal before they met with any one which is considerable. But to reward their perseverance, the fifteenth bed proved more than five feet in thickness; and the seventeenth, separated from the former by twenty-four beds of slate, iron-stone, sand-stone, and one small bed of coal, is nearly eight feet in thickness.

Mr. Kirwan mentions a pit, in which the miners sunk through one hundred and four-score feet of clay, under which they found a ten feet bed of coal, on a bed of clay of nearly the same thickness. They had then in succession coal, one foot and a half; clay, nearly four-score feet; culm, three feet; micaceous sand-stone, like the pennant-stone of Hanham, nearly sixty feet; clay almost as thick, over coal of nine feet in thickness. King Pit is one thousand and twenty feet in depth, and has five beds of coal, of which one is eight feet, one eleven feet, one five feet in thickness, dipping West one foot in ten, and running more than half a mile under the sea.†

The cannel coal is confined chiefly to the parishes of Caldbeck and Bolton.

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* Dixon's Life of Dr. Brownrigg.

† Memoirs of the Phil. Tran. of Ireland.

Durham and *Northumberland* contain a considerable portion of the great Northern coal field. At St. Anthony's colliery, two miles East of Newcastle, they count seventeen beds of coal from the surface to the depth of one hundred and thirty-five fathom. But in a pit at Bigg's colliery, two miles to the North East of the former, they cut through thirty-three beds of coal, and sunk to the depth of one hundred and ninety-three fathom, in pursuit of the low main coal, which is the lowest bed at St. Anthony's, and had not then cut it.

These beds of coal are from two inches up to more than six feet in thickness, separated by beds of argil and of siliceous schist.

The two most considerable beds of coal at Newcastle, are the high main and the low main, each about two yards in thickness. The former extends twelve miles from East to West, and six from North to South, and forms a dish, rising from the centre to the circumferance, about one foot in twenty Westward, but more rapidly to the East. The other beds below this extend through great part of Durham, and a considerable way into Northumberland, which abounds in coal, more especially the South East quarter of the county, where the most numerous, the thickest, and beds of the best quality are found.

It is worthy of our notice, that the high main and the low main are not parallel. At St. Anthony's and Lawson's main they are sixty fathom apart, and at Brigg's, more than ninety-five.

The Newcastle collieries, now so extensive as to supply the metropolis with its dependencies, and parts of the continent, began by digging coal on the crop of the seams in the Castle Field, within the limits of the city, which, in the year 1240, under a grant from Henry II. took possession of that treasure.

This grant to the corporation being extended in the succeeding reigns, the collieries became more considerable, and in the year 1357, coals were exported to the metropolis.

All the workings were shallow, and it was not till the year 1730 that, by the assistance of steam engines, they could descend in depth.

From Newcastle the coal dips, for about five miles, to the South East, then rises till, at the distance of three miles, it crops out on the sea shore, a little below high water mark.

The two most considerable seams of coal are those from which the London market is supplied. There are at present only two collieries working the low main coal; these are Tyne main, near Gateshead, and Sheriff Hill. It is remarkable that this coal varies in quality as we proceed towards the South; for on the Tyne it leaves no residuum in the form of coke, but on the Wear it binds well, and forms good cinders. This change takes place immediately on the South side of the large downcast fault, which divides Sheriff Hill colliery into distinct and separate parts.

The quantity of coal exported from Newcastle has been constantly increasing, and in the year 1795 amounted to five hundred and five thousand six hundred and fifty chaldrons, of two tons thirteen hundred each.

In *Scotland*, the country round Glasgow abounds with coal, in beds of from half a line to nine feet in thickness, connected, like all the preceding, with mountain lime-stone, red ground, and iron.

Along the range of the Clyde, the mineral strata dip towards the river; and in the same range the coal beds, like those of the

Forth in the *Lothians*, Fife, and Sterling, are bounded at a distance by the Grampian granite range, and the ridge of granite which extends from St. Abb's Head, in Berwickshire, to the Mull of Galloway. Between these granitic boundaries we have lime-stone and sand-stone, with the silicious schist of the red ground.

To the North of this coal range mention is made of another, separated from it by high mountains, and stretching from Buchan Ness on the East, to the island of Jura on the West.

What depth in the earth coal extends, it is not easy to determine.

At Puckle-Church, after sinking sixty feet through lyas, and one hundred and fifty-three through the red ground, and six feet in duns, they met with coal, and below the coal beds red ground again, in which they sunk one hundred and eight feet, without finding either more coal or lime-stone.

In Staffordshire, particularly in the parish of Rowley, having penetrated three hundred feet in search of the main coal, they sunk again twice that depth through various strata, till they arrived at the great lime-stone of Lord Dudley's quarry. The same circumstance has been observed at Dudley.

At Clydach, in Monmouthshire, Mr. Frere has laid bare the strata for about three hundred and sixty feet below his beds of coal, which are in number nine: These are elevated about one thousand eight hundred feet above the level of the sea. The strata penetrated by him are—1. Iron-stone, bedded in argillaceous shale; 2. Silicious schist, alternating either with mountain lime-stone or with argil, in beds of forty or fifty feet in thickness; 3. Iron nodules, in argillaceous shale, forty feet; 4. Pudding-stone and breccia; 5. Red shale and sandstone alternating, to an uncertain depth.

At Syrhowey seventeen beds of coal have been particularly noticed, mostly separated by beds of iron-stone; under which is found a grit rock, about three hundred feet thick, containing a two foot vein of coal: this they call Farewell Rock. Under it is found a lime-stone pudding, of twelve or fifteen feet, on a bed of lime-stone, which is estimated at seven hundred feet; beneath which they have a red rock, which they call Duns. This, I apprehend, is argillaceous.

In the Forest of Dean, as I am well informed, the strata of clay, sand, pudding-stone, lime rock, iron-stone, and red ground rocks, beneath the coal, measure from twelve to eighteen hundred yards in thickness.

XIV. IRON-STONE.

We must not pass beyond the limits of the red ground, coal, and lime-stone, without noticing the *iron-stone*, every where attendant on these strata. This valuable metallic earth is found either in balls, or in continuous strata; but the balls are by far the richest. These lie in argil, between the beds of coal. Hence the supply for Colebrook Dale and Carran. In South Wales it is remarkable, that the exterior range of coal, which is bounded by mountain lime-stone, is most abundant in iron-stone. As an evidence of this, no fewer than forty-one iron founderies have, within these few years, been established in this range.

Of these founderies one is on the Swansea river, another at Ponty Dyllys, one high up on the Neath river, and two at Neath. These procure all their iron-stone from Abernant. Other furnaces are found at Hyrwain, Aberdare, Cyfartha, Plymouth, Pendarren, and Dowlais, in the Merthyr Vale, at Romney, Syrhowy, Tredega, Beaufort, Ebbw, and Nanteglo, on different streams flowing into the Usk near Newport; at Clydach, near Abergavenny; at Blaen Aton, at Varteg, and at Ponty Pool.

The interior range of coal, distant from the lime-stone, has so little iron that only two furnaces have been erected on it, and these belong to Mr. Raby, at Llanelly.

In one of the Madely Pits, North of the Severn, in Shropshire, one bed of iron-stone, at the depth of about five hundred feet, is near thirty feet thick; and beneath this are five other beds, composed chiefly of balls.

In the Staffordshire coal mines, numerous strata of earth and iron-stone intervene between the coal and lime-stone.

We are told, that in the county of Kilkenny great quantities of iron-stone lie on the surface of the earth, but in general it is found between the beds of slate, in flattened nodules horizontally disposed.

The collieries of Mendip abound in iron ore; but it is not carried to the forge.

Whenever the collieries in the Forest of Dean shall be sufficiently laid open, they will yield an abundant supply of iron, to increase the wealth this nation has derived from the bowels of the earth.

XV. THE METALLIFEROUS, or MOUNTAIN LIME-STONE.

This rock, as I apprehend, is the suillus marmoreus of Linnæus. In the West of England it makes its first appearance at Padstow, and in Veryan. It meets the eye every where in the vicinity of Plymouth, where, by its wide extended and high cliffs in Berry Head and Bob's Nose, it forms Torbay, and protects Babycomb Bay from the incroachments of the Western Ocean.

From thence we trace it by Exeter, in numerous elevated and insulated rocks, of a mile or two in circumference, till it approaches Bridgewater. Some considerable mansions, particularly Enmore Castle, Bremore House, and Sir Philip Hales, at Cannington Park, are built on it. It occupies the whole of Mendip, appears in great magnificence at Mells, and excites our astonishment in its stupendous cliffs at Chedder. It powerfully attracts our notice at Clevedon, Wraxal, Belmont, Backwell, Chelvy, and Brockley; at Bristol Hotwells; on Leigh Down, Durdam Down, King's Weston, Aust Passage, Chepstow, and Caerleon, in the lofty cliffs on which stands Morlais Castle; and in the Banks of the Wye, as far as Ross, in Herefordshire. In Worcestershire we see it reclining against Malvern Hill, and find it in the country West of Birmingham, in the Peak, and through the N. W. of Derbyshire. It forms the basis of Ingleborough, Wharnside, Pennigrant, and other mountains of Yorkshire, which rise from two thousand to three thousand feet above the level of the sea, and it constitutes the high rocks of Durham and Northumberland.

Near Bath this lime-stone may be seen at Wick, where it produces romantic scenery.

But here I must observe, as highly worthy of attention, that the mountain lime-stone does not run through the kingdom in one regular stratum; but forms, as we have already seen, elliptical basins of vast extent. One of these may be traced in the vicinity of Bath. If we suppose it to begin at Clevedon and Leigh Down, and to be continued on to Durdam Down and King's Weston, we may trace it thence by Walton, Westbury, Compton, Redwick, and Aust, where it turns to Almonsbury, Alveston, Titherington, Rudgway, Wickwar, Sodbury, Wapley, Codrington, Deynton Mill, Wick, Granham Rocks, and Beech Lane, which is beyond Lansdown to the North, where it sinks under ground. Here we meet with a considerable interruption of the lime-stone, no longer visible, and in its place see only exposed to view the great oolite. From Elm, near Mells, we proceed with our ellipsis through Mendip, by Leigh, Oakhill, Ashwick, Blagdon Lodge, Chedder Cliffs, Bleydon and Uphill, to Brean Down, thence by Winscombe, Worleberry, Swallow Cliff, Woodspring, and Clevedon, to Leigh Down again. But, in the intermediate space, between Beech Lane and Mells, vestiges have been discovered of this rock more than fifty fathom deep, in a pit sunk for coal, at Bath Easton.

This forms the great ellipsis including the coal fields, from which Bath and Bristol have been supplied for ages. Within these limits we have subordinate ellipses of lime-stone, one of which includes, in its N. E. portion, Nailsea Moor. This elevated ridge commences at Clevedon, passes by Tickenham, Leigh Down, Wraxal, Belmont, Ashton, Barrow Court, Backwell, Brockley, Mendip, Banwell, and Brean Down, where it again meets the Severn, and sinks under the sea.

In *South Wales* we have an ellipsis upon a more extensive scale. This begins in St. Bride's Bay, with the cliffs of Haroldston and of Galtop, in the parish of Talbenny. From Haroldston it proceeds by Picton Castle to Slebitch, Monkton, Ludchurch, and Narberth, which is built upon it, to Pendine, Llanghorne and Llanstephan Castle, where the two rivers Tave and Towy enter Caermarthen Bay. From thence it continues its progress Eastward to Carreg Cennen Castle, near Llandilo Vawr, and Capel Gwynvai, on the black mountains. Thence we trace it to the mountains between the sources of the Neath and Usk, and from the great hills of Blaen Cwm Collwyn to Morlais Castle, North of Merthyr, and the cliff with the elevated ridge of the Blorens and of other hills, which run parallel to the Usk. Having passed Abergavenny, it inclines to the South, and comes to Ponty Pool, where, turning to the West, it passes by Pontwmbalwm, Caerphilly, and Castle Coch, and the vicinity of Cardiff. Thence it proceeds South of Cowbridge, by Llantrissent, Bridgend, Newton, the Mumbles, and Penrice, to Wormshead. The deficient portions of this ellipsis are lost in Swansea and Caermarthen Bays, but are to be traced in the sunken rocks, between Rosilly Bay and Caldy Island. From thence it goes by Tenby and St. Florens, to Carew, Pembroke, Williamston, and Milford Haven; to the North of which it closes on Talbenny again.

Throughout the whole of this circumference, the lime-stone dips toward one common centre.

This same body of lime-stone, which, from Cardiff to Cowbridge dips to the North, extends Southward, where, as if it formed part of another ellipsis, it dips to the South, towards Barry Island, which is red ground. The whole of this basin must have vanished, and the only vestige now remaining, is the steep holm in the Bristol channel, where we have mountain lime-stone, dipping to the North West.

The *Monmouthshire* mass of lime-stone at Penhow Castle and Chepstow, following the Wye, of which it forms the Eastern boundary, to Clear Well, Mitchel Dean, and Beacon Hill, dips Eastward, and South East to form the elliptical basin of the Forest of Dean.

In North Wales, the mountain lime-stone is abundant.

In Caernarvonshire, we meet with it at Crickaeth, from whence it stretches Northward across the county, to its capital. Thence taking the direction of tha Menai, of which it forms the Eastern boundary, it proceeds to Bangor, where it gives place to the central rock of the Snowdon chain, which terminates in Penmaenmawr, near Conway, Bay. At Ormes Head it again meets the eye, and forms a barrier against the encroachments of the sea, as far Eastward as the River Dee, where it turns to Holywell, and through the vale of Clwyd, to the Eglwyseg Rocks, in Llangollen vale. Then passing due South, it appears in the opposite side of the valley, is broken near Oswestry by the Ferwyn mountains, appears again at Llanymynech, and is at length stopped in its course by a line of primitive mountains, stretching Northward out of Radnorshire. At Llanymynech, the hill, viewed from the South, resembles a wedge, steep to the West, and dipping Eastward till it sinks into the earth. This rock is principally excavated for lime. From twelve to twenty distinct beds appear, chiefly horizontal, but curvilinear, and in one place dipping very fast. Twelve of these beds measure sixty-seven feet. They are chiefly red, and at the depth of one hundred and five feet rest on red ground. A range of this lime-stone, stretching from Llanymynech and the Breddin Hills, to Ruabon, forms the Western boundary of the plain of Shrewsbury.*

The rocks on both sides of the Severn, at the entrance of Colebrook Dale from Shrewsbury, are composed of lime-stone, and form the Northern extremity of a long range, which passes by Wenlock Edge and Benthal Edge, in a South West direction, as far as Mochtre Forest, near Ludlow.

The *Staffordshire* lime-stone range has been already noticed, but on Dudley Castle Hill it requires more particular attention, because the surrounding strata of argillaceous schist and coal all rise towards one common apex, and are all incumbent on this lime-stone. Here the protruding rock is visible, and may therefore encourage a suspicion, that a similar rise in the coal beds of Kingswood, near Bristol, may have been occasioned by a similar cone of subjacent lime-stone.

In *Nottinghamshire*, this lime-stone extends West of a line, drawn from the river at Shire Oaks nearly South to the River Lene, near Wollaton and *Radford*, but is not found East of the Lene, where the *red* ground commences. The corresponding portion of this elliptical basin is said to occupy the Eastern border of *Derbyshire;* but, for this we must refer to Mr. Farey.

West of *Newcastle* we have the lime-stone; but to the East, it has been either carried off or sunk under the waves, for in that direction the basin is incomplete.

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* Aikin's Report.

Cumberland exhibits lime-stone to the East; but its Western limits are concealed by the waters of the ocean. The several ranges of this rock, inclosing various lime-stone basins, may be readily traced by referring to what I have said on the collieries of Whitehaven.

The mountain lime-stone is productive of iron, lead, copper, calamine, and manganese. The Mendip Hills yield many lead mines, much calamine, and abundance of manganese. The Flintshire mountains contain lead and calamine in great profusion. But the greatest quantity of copper has been obtained from the Acton mines, in Derbyshire.

The mountain lime-stone has numerous and extensive caverns, and is most abundant in water falls.

Other beds of lime-stone have been noticed in *Derbyshire*, by miners and by colliers. Under Aldstone Moor, two have been penetrated for coal, measuring twenty-four and sixty feet.

From one lead mine I have an account of four lime-stone beds, measuring from one hundred and fifty to one hundred and eighty feet in thickness, separated from each other by beds of toad-stone, which are of various thickness, from fifty to one hundred and forty feet. These I have never seen, and for want of specimens I am unable to ascertain the species of lime-stone which these beds contain. From the indefatigable researches of Mr. Farey, we shall gain information.

The species I have traced has characters by which it may be readily distinguished, and, as commonly it meets the eye in the intermediate space between chalk and granite; it serves to fix the boundary between the coal and the metalliferous districts, to both which it is related.

On the continent, between the granitic regions of Mont Blanc and Heidelberg, lime-stone twice intervenes; but in the latter of these mountains and in the Hartz, it occurs nine times, separated, however, by dykes of basalt.

XVI. ARGILLACEOUS SCHIST AND SLATE.

The first range, in which argillaceous schist appears to the S. W. of the mountain lime-stone of Mendip, is on the Quantock Hills, bounded to the West by Exmoor.

At Challacombe, or Shallowcombe, in Exmoor, the slate beds alternate with mountain lime-stone. Thus—1. Slate, seven feet; 2. Lime-stone, twenty-two feet, including a two feet bed of slate; 3. Slate, sixteen feet; 4. Limestone, eight feet; 5. Slate, thirty feet; 6. Lime-stone, not quarried; 7. Slate, of uncertain thickness.

Schist, or slate, is seen at Holsworthy, Torrington, Barnstaple, and Ilfracombe.

It surrounds Dartmoor, and appears on the sea shore near Painton, in Torbay; and may be traced either in the sea or on the shore from thence, by Berryhead, Portlemouth, and Plymouth, as far West as the Land's End, in Cornwall, where it contains the veins of tin and copper. About Plymouth it alternates with micaceous lime-stone, but from the River Tamar to Liskeard the schist prevails, and in that district the best slate is found.

On the Northern coast of Cornwall, at *Denyball*, near *Tintagell*, slate quarries have been opened on the most extensive scale. In this spot we see an excavation near a thousand feet in length, three hundred wide, and sunk to the depth of two hundred and fifty feet, here distinctly dipping South West.

In Pembrokeshire, slate appears West of the lime-stone, coal, and red ground. It is procured in St. Bride's Bay, and the adjacent country. The black, blue, and red slate, sent into the market, is obtained principally about Newport, Dinas, and Kemes, at Coed Cadw, in the parish of Nevern, and in the whole tract of country between the River Nevern and the sea. Here the dip is to the South.

In Caernarvonshire, slate every where surrounds Snowdon, interposed between its granitic offspring and a ridge of lime-stone. It covers the Northern hanging of that stupendous mountain, and at Conway, which yields vast quantities for exportation, it extends in a line parallel to Penmaenmawr.

It is obtained at Llanfflewyn, in Anglesea, and in various parts of the Isle of Man.

At Kerridge on the Hills, near Macclesfield, in Cheshire, much is raised for the supply of the adjacent country.

In Derbyshire, it is found on Chinley Hills, and at Hayfield.

Westmoreland abounds with it.

In the Northern extremity of the Isle of Arran, the sea has formed a section of the strata, and discovered the mountain lime-stone, incumbent on micaceous schist.

Perthshire, in its Northern borders, produces excellent slate, which, like the preceding, stretches to the North East, and dips towards the South. Indeed, from Portpatrick, on the Western coast, to St. Abbshead, in the East, a tract of schistous mountains has been accurately traced by Dr. Hutton. And round the coast, in the shires of Ayr, Dunbarton, and Banff, slate has been observed, as far as Berwick upon Tweed, where it meets the mountain lime-stone, the red ground strata, and the coal.

In short, wherever I have traced the mountain lime-stone and granite, schist and slate have uniformly come between them.

XVII. PUDDING STONE.

This almost universally appears between schist and granite. It has been noticed in the West of England, and is visible in Scotland. In Perthshire, about Callander, a stratum of this rock appears running from S. W. to N. E. for several miles, through rivers, lakes, mountains, and vallies, parallel to strata of schist and of mountain lime-stone.

Dr. Hutton particularly notices this rock, called by M. Voigt *Sol mort rouge*, and, by Professor Link, Todte Liegende, as interposed between his vertical schist and horizontal strata of sand-stone and coal.

In the vicinity of Bath we find a silicious pudding-stone, here called mill-stone, which constitutes part of the red ground; but this bed is perfectly distinct from both the pudding-stone which covers, and that which is subjacent to the mountain lime-stone, as discovered in the several bays South West from Swansea to Burry River. In this direction, between the Mumbles and Wormshead, are four high mountains, Caven Brane, Llanmadoc, Caliver, and Rosilly, entirely composed of silicious breccia and pudding-stone, rising through mountain lime-stone. Each of these are long ridges, which, viewed in one direction, appear conical. The charge is composed of white quartz crystals, which are not merely in contact with each other, but frequently the convex surface of one coincides with the concave surface of the other. Caliver has large rocks, resembling petrosilex, and containing zeolite.

XVIII. BASALT.

The term *basalt* is confined by Albert Fortis* to a compact homogeneous substance, resembling cast-iron in hardness, colour, grain and fracture, of which the varieties may contain globules of chalcedony, zeolite, and calcareous spar, or shingle of granite, schist and bole. He attributes the columnar forms of basalt to accident, as being common to porphyry, to grit, and even to gypsum.

According to Bergman, *basalt* contains silica, 50; alumina, 15; magnesia, 2; calcareous earth, 8; iron, 25. In Rowley Rag, Gregory Watt found the subsequent proportions: silica, 475; alumina, 325; iron, 200; in which proportions he nearly agrees with Withering.

Trapp, of the Swedish mineralogists, *schwartz* stein of the Germans, *whin-stone* of Scotland, *toad-stone* of Derbyshire, *rowley rag* and *rad-stone* of Staffordshire, and *amygdaloides*, are all, as I conceive, nearly synonymes. It may here be needless to remark, that the last appellation is taken from its usual contents of zeolite, of prehnite, of calcedony, of mica, or of calcareous spar, supposed to resemble almonds. *Toad-stone* refers to its dark colour, with its spots; *whinstone*, to its being commonly attended by whins, chwyn of Wales, that is, furze, or gorse; *schwartz stein*, to its dark colour; *radstone*, to its redness; *rowley rag*, to the village near which it has been found; and trapp, to its forming steps.

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* Tom. I. p. 173.

This substance, generally considered as allied to basalt, abounds in England, Scotland, and Ireland. It has been particularly noticed in Derbyshire, alternating with lime-stone, and appears remarkably on the Wrekin, in Shropshire, where no basaltic columns have been seen. It forms a range of hills in the Southern part of Staffordshire. The lime-stone rocks of Dudley bed up against it, and the purest coal comes up to the surface against the lime-stone. In Tividale, under the rowley rag, the coal is said to be completely charred.

Sampson, in his account of Londonderry, takes notice of the reiterated *transitions* from trapp to basalt. Descending from the rock on which the Mussunden Temple stands, he found under the soil and rubble—1. Amorphous basalt; 2. Steatite; 3. Basalt; 4. Trapp; 5. Tabular basalt; 6. Basalt and trapp, with zeolite and steatite confused; 7. Trapp; 8. Basalt; 9. Trapp and zeolite; 10. Basalt and steatite; 11. Steatite; 12. Trapp.

These curious substances differ from most of the calcareous strata, inasmuch as, although sometimes stratified, they are never laminated. They frequently appear in veins, intersecting the natural strata of the country, and always bear resemblance rather to matter which has been fused and violently injected among other strata, than to a gradual deposit, subsiding quietly in the bosom of the ocean.

Basaltic columns first attracted notice at the Giant's Causeway, in the county of Antrim. From thence they extend over a tract of country at least forty miles in length by twenty in breadth. At Fairhead they resemble black schorl, and form a cliff four hundred feet high; but in the interior of the country, basalt occupies the mountains to the height of six hundred feet.*

The columns of the Giant's Causeway are incumbent on white lime-stone, resembling the white lyas of Bath, but containing flints. They are exceedingly deranged, rising high in some places, in others depressed below the level of the sea. Their proper base has been considered to be silicious schist, and Dr. Hope discovered alternations of the basaltic rock, with beds of schist, which carry fossil shells, particularly ammonites.† In fact, the white lime-stone seems to be indurated chalk, and, if so, the schist is the subjacent bed of green sand, converted into stone.

In the adjacent country are found white lime-stone, sand-stone, coal, and iron. Two miles East of Ballycastle, argillaceous strata appear both above and below the coal, under which is the same kind of mill-stone, or silicious pudding-stone, which has been noticed by travellers as being uppermost in Derbyshire.‡

When the Giant's Causeway had been for years contemplated with wonder, a more stupendous mass of basalt attracted attention on the opposite coast of Scotland, and led to multiplied discoveries in other parts of the globe.

Corresponding with the North coast of Antrim, from the Giant's Causeway to Fairhead, we have the Isles of Ragherry and Staffa, with other of the Hebrides, all worthy of our notice. *Staffa,* two miles in circumference, and one hundred and fourteen feet above the level of the sea, is entirely surrounded by columnar basalt, excavations in which form stupendous caverns. *Mull* is twenty-two miles long by sixteen wide, and has mountains of lava rising at least to the height of fifteen hundred feet.* In the Island of *Arran*, basalt is found in numerous veins, some of which are thirty feet thick, traversing the micaceous schist, together with its covering of lime-stone, and even penetrating the granite.† In a word, the whole tract in which the Hebrides are scattered, according to St. Fond, is volcanic.‡ Basalt abounds on the sea coast in Argyleshire. Dunbarton Castle stands on it, and all the hills round Glasgow shew it.

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* Hamilton's Antrim, p. 114.

† Playfair, § 252.

‡ Whitehurst.

Eastward of this line, in various parts of Scotland, attentive observers have discovered basalt. It is particularly noticed under Stirling Castle, and in the shires of Perth and Fife, in the vicinity of Edinburgh, on the Castle Hill, and on Arthur's Seat, where it is incumbent on white lime-stone, and covered by schist. In Dunbar it meets the eye, and in general we may remark, that all the low country in which coal is found, is attended by mountains of whin, trapp, and basalt.

These substances have been observed on the Western borders of Snowdon, in *Caernarvonshire*,§ on the summit and the Western declivities of Cadder Idris, at Dolgelle, and the sea coast of Merionethshire.‖ I have collected them near Oakhampton, and from Spence Coombe, near Crediton, where they had never attracted notice.

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* St. Fond, vol. 2.

† Jameson's Shetland.

‡ St. Fond, vol. 2.

§ Aikin's N. Wales.

‖ Strange, in Ph. Tr. 65, p. 16. 17.

In the cabinet of Sir John St. Aubyn, I have admired four perfect crystals of field spar in lava, from Drachenfeld.

Dr. Richardson, of Belfast, observed the cavities of basalt in the Giant's Causeway, filled with water. Similar instances are mentioned by Stucke, in Germany, and, I understand, that most geologists are now satisfied that basalt is indebted to the ocean for its production.

This subject will be resumed when I shall proceed to treat of dislocation.

XIX. GRANITE.

In England, granite is confined chiefly to the Western coast. We trace it from Guernsey and the Scilly Islands to the Land's End, in Cornwall, where it sustains the shock of the Atlantic Ocean; and through the centre of the county, we behold it lifting up its venerable head in all the most elevated peaks. One of these is Carnmarth, near Redruth, and is highly interesting, because, by means of the copper mines in the vicinity, we trace the granite dipping South East under schist, as may be particularly noticed at Dolcoath, Tresavean, Wheal Virgin, and Poldice, in all which mines we discover the lode, in schist, near the surface; and in granite, as it descends below the schist. To the West of this mountain stands Carnbrea, which rises seven hundred feet above the sea, and whose dip observes the same direction. Dolcoath mine exhibits granite to the depth of twelve hundred feet.

In Devonshire, granite, rising up from under schist and mountain lime-stone, occupies Dartmoor, and shews itself in circumjacent districts.

We meet with it in the Northern and Eastern limits of the Malvern Hills, which, rising one thousand four hundred and forty-four feet above the level of the sea, stretch themselves N. and S. about nine or ten miles in length. It is said, that on the summit of Mount Sorrel the granite again lifts up its head.

Snowdon, which rises three thousand six hundred feet above the level of the sea, is certainly allied to granite, as appears by its genuine offspring in its most elevated peaks; and Cadder Idris, which is two thousand eight hundred and fifty feet above Dolgelle, has probably its central granite.

In Scotland we observe three granitic chains. The first extends from the Mull of Galloway to St. Abb's Head.

The second from Arran and Ila, through Argile, and the whole range of the Grampian Hills, to Buchan, and round the coast from Portsoy to Aberdeen.

The third passes from Mull, through Ross and Sutherland, to the Shetland Islands.

In this chain we particularly notice Ben Wewis, and Ben Cliberg. In the preceding chains we have Ben Lomond, Ben Verlich, Ben Cruachan, Ben Nevis, Ben Lawres, Ben Gloe, Ben Derg, Ben Bourd, Ben More, Ben Lidia, Ben Awn, and Ben Ichie. These mountains rise from three thousand to four thousand three hundred and fifty feet above the level of the sea.

As to the question which respects the stratification of granite M. de Luc has given us most satisfactory information in his Geological Travels. Both he and Saussure long since affirmed, after the most careful examination, that Mont Blanc and the aiguilles surrounding it are stratified. And now, the former of these geologists has, by patient investigation, discovered granitic quarries in Cornwall, near St. Colomb, in which the stratification is evident; and in these quarries he ascertained a fact which is highly interesting, that the crystals of feldspat always lie in the same direction with the strata.*

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* De Luc Geo. Tr. v. 3, p. 192.

THE CROP OF STRATA AND THEIR DISLOCATION.

I HAVE stated that in our island the range of strata, that is, their horizontal section, is from South West to North East, and it has been made appear, not only that the superior strata usually rise towards the North West, but that, whenever we meet with them, as we proceed in this direction, they soon disappear again.

Their termination at the surface is their basset, or their *crop*, and this, if bold, elevated and abrupt, is called their *scarp*. Now as this, by the action of the air, rain, dew, and frost, must be fretted, decomposed, and rent, its spoils will form a deposit at its base, which, by accumulation, will rise in a slope against the rock, from which they fell. For want of a more commodious expression, we may call this kind of slope the *apron*.

The superior surface of a stratum is considered as its *back*, and it is supposed to turn its back on the country from which it rises. In like manner, it is said to *look* towards the country to which, in rising up, it directs its course.

The crop is not, in all cases, either visible or easily to be discovered. The difficulty of detecting this may be sought for in the nature of the materials, which constitute the contiguous strata. For as, supposing the stratum to consist of hard materials, or of such as are not apt to be decomposed, and to be incumbent on others which are soft and subject to decay, the crop will be both visible and bold; so, should all the contiguous strata contain none but soft materials, they will present no scarp, but, mingled together, they will be spread upon the surface, and their crop will be perfectly concealed. Nay, one or more of the superincumbent strata may be deficient in their superior portion, and form a feather edge, completely covered by the soil. In such circumstances deep excavations are required, as in the operations practised by miners, of *hushing*, *shodeing*, and *trenching*, to detect the crop.

Again, by the mouldering of an elevated scarp, numerous crops may be concealed, or they may be so blended as to conceal each other.

In rivers, the crop of any hard stratum usually forms a *Ford.* Thus it is at Bradford, on the great oolite; at Iford, Freshford, and Mitford, on the bastard free-stone; at Telsford, on the forest marble; probably at Bathford, certainly at the Old Bridge of Bath, and at Twiverton, that is Two Ford Town, on the lyas beds; at Saltford, Swinford, and all the Radfords, on the red ground rocks.

The fords attracted passengers, and established the high ways; and, as these were liable to be interrupted by floods, on each side of the ford public-houses were constructed, for the accommodation of the traveller, which laid the foundation for villages and towns. In process of time fords gave place to bridges, yet the appellation continued to be used, when the reason for that appellation had been long since forgotten.

As crops gave rise to fords, so likewise did they to weirs, for which they yielded firm foundations, when it was found expedient to convert undershot wheels into breast mills.

In mountainous countries it is remarked, that every ridge, or chain, has on one side a gentle slope, whilst the opposite is either steep, or even precipitous. The angle these slopes inclose, depends on the tenacity of the materials which originally composed the scarp. If these are hard, the angle will be acute; if soft, it will be proportionably obtuse. Hence it is, that even in countries which are new to him, the skilful observer will, at the greatest distance, judge what substances compose the hills and mountains which present themselves to view.

Chalk hills have commonly a waving line, and in some places exhibit very striking crops. Those which overhang the vale of Pewsey are particularly worthy of attention, because they are supported by hard beds of the rubby chalk, which bid defiance to the destructive elements. In consequence of this the scarp is apt to be precipitous.

In the interior of Kent and Sussex, we have two distinct crops of the chalk strata, running East and West, for the Northern range rises to the South, and the Southern range dips into the sea.

In the Isle of Wight, as we have seen, the high hills are chalk, and continue to the back of the island, where their fragments, with those of the subjacent rocks, have formed an extensive deposite, which may be about two hundred feet above the level of the sea. Over this, if my memoranda are correct, a cliff of sand rock rises one hundred and forty-three feet, with a chalk cliff above it, all the sand strata dipping to the North. Here it must have been more than common dislocation, because both the chalk and its superincumbent clay become nearly vertical, as the clay itself does on the opposite coast of Hordwell.

The perpendicular Southern cliff evidently discovers marks of its having been, for a long period, washed and fretted by the undulations of the sea, and in many places, but especially at Steephill, we may be convinced that the cliff was formed and fretted thus, before it was either lifted up out of the ocean, or left exposed by the retreating of the waters. For on the under surface of a projecting rock, in the garden lately occupied by Mr. Talmarsh, are to be seen *branches of coral*, and many tender shells, which, had they been deposited previous to the formation of the cliff, must, by the separation of the fragments which compose the apron, have been broken off.

Among the strata, I observed one near St. Boniface, of the thickness of two inches, in which I counted nineteen several laminæ, distinguished by the difference of their colours.

The country round Bath is extremely broken, and presents numerous crops, but the most remarkable are those of the great oolite, which may be seen to advantage near Bath, either at Ancliff, Bradford, Bathford, and Farley Down, or more distinctly on the Cotswold Hills to the North, and near Sherborne on the South. Those of the bastard free-stone are visible at Beechen Cliff and Toghill, or more to the South, beyond Marston Magna. The lyas crops magnificently at Kelweston.

In each of these, although a conspicuous scarp remains, yet by its gradual decay, vast fragments of the rocks have formed an apron, which is rising up to hide it. Every winter's frost, followed by thaw, and assisted by rain, adds fresh tumblers to the accumulating heap. This kind of operation is too conspicuous to escape the notice even of the most inattentive observer, in all the hills surrounding Bath, and may be seen in every quarter of the globe.

On the Northern extremity of Lansdown, near the monument, we meet with, not the mouldering of a scarp, but its dislocation; for here the crop of the great oolite has fallen down on the back of the bastard free-stone; and the intermediate bed of clay, with its fullers' earth, is wanting. At this very time* Mr. Bush is removing the rubbish, and has laid bare some of the best beds of the oolite, which, instead of dipping gently to the South East, here fall to the North in a regular succession of fragments, between which are considerable chasms. The bastard free-stone, on which these fragments rest, is visible, reclining on its bed of sand, as that does on the blue marl and lyas, which here dip North, towards the Severn.

Such dislocations are not uncommon.

Along the extensive range, from Bowden Hill and Lockswell Heath to Derry Hill, near Calne, in Wiltshire, a similar effect to that above described has taken place. This may have been occasioned by incroachments on the great bed of clay, which originally supported the coral rag, with the superincumbent strata. For here the crops of the superior oolite, of the calcareous grit, and of the coral rag, with their attendant clays, have fallen down into the vale, and formed a declivity of great extent.

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* March, 1803.

On the summit of this high ridge we have the quern sand, with its rock. In the subjacent plain, to the N. E. appears the Kelloway rock, with a slight covering, derived from the incumbent bed of marl and clay. From Derry Hill to Wick Hill, the crop of the superior oolite stands extremely bold, and the ridge is precipitous, but the inferior strata are covered by its spoils.

It is highly worthy of our notice, that, in the direction of the Severn, North of that river, and even for a considerable extent to the South of it, all our superior strata are wanting. These are the chalk, sand, superior oolite, calcareous grit, coral rag, Kelloway rock, corn brash, forest marble, great oolite, and, finally, the inferior oolite, or bastard free-stone, which, failing in succession, shew their crops looking to the North West, and help to form what may be called, according to the Ablé Rozier, the basin of the Severn. Proceeding a little to the North of the high road, which leads from Bath to Gloucester, we may direct our steps, all the way from Toghill to Selsley, on the crop of the bastard free-stone. In this whole extent, we command a view of the rich vale in which the Severn winds its wayward course, in lyas, in red ground, and in mountain lime-stone; and at a distance, trace the Monmouthshire hills, by which this enchanting prospect is bounded to the West.

As we proceed from Bath toward Shepton Mallet and Dorchester, we meet with numerous crops of the great oolite, but in ascending up from Radstock, where the red ground and lyas meet together, we rise to the South near three miles on the back of the lyas beds, which here invert their dip, till we approach to Stratton, where these beds crop out and give place to inferior beds, first of the red argillaceous schist, and then of pudding-stone, whose crop stands up bold and precipitous over the vale, in which is Nettlebridge, watered by the Ashwick stream. Here coal beds crop out.

Beyond this vale we rise up very steep on the back of the mountain lime-stone, which forms Mendip Hills, and stretches its crest, in a waving line, from Shepton Mallet, by Wells, to Axbridge, Uphill, and Brean Down, where this rock projects its rugged cliffs into the Severn. All the inferior beds here dip North East, and and consequently their crops look to the South West.

In the immediate vicinity of Bath, the strata are intersected in every possible direction, by *Coombes*, or *Cwmm* as the word appears in Welsh, that is, by deep and narrow vallies, most frequently destitute of rivulets. Hence it is that, as we proceed from South East to North West, we observe in succession numerous crops of the same stratum. But, as every portion of each stratum, interjacent in the whole ground between the Coombes, has a crop, so likewise has it an inferior termination and sides, which frequently appear exposed to view.

Now the same kind of dislocation already noticed in the crop of the great oolite, near the monument on Lansdown, may be observed in the inferior termination of the same rock at Murhill, South of Winsley, opposite to the conflux of the Frome and Avon rivers. For the rock, which here forms an elevated cliff of about one hundred and forty feet, being unsupported by its subjacent clay, has slipped back and subsided on the bastard free-stone, leaving very extensive chasms, some of which are empty, but others have been occupied by fragments of the rock. Some of the fragments, precipitated to a considerable distance from the cliff, and almost buried in its ruins, measure more than forty feet by twenty. One of these, which dips 45° South towards the river, contains more than five thousand cubic feet of free-stone.

In this spot we have a remarkable phœnomenon, for the inferior beds of the great free-stone rock, near forty feet in thickness, have sunk, and separated themselves, through a considerable extent of country, from the superior beds, leaving a fissure between them of about three feet in diameter, which has been occupied by clay.

In this spot, the vast fragments I have mentioned point towards the vale beneath, as if they were precipitated from the cliff. But near the Dundas aqueducts, and at Dunkerton, I have observed a more remarkable phœnomenon; for there, the inferior termination of the bastard free-stone has subsided, fractures have ensued, wide chasms appear, and numerous faults have been created: but these enormous fragments of the stratum have not been precipitated, nor do they point towards the vale beneath, but seem to be sliding back, and dip into the hill from which they proceed, and in which the whole rock appears.

In such a position, the inferior surface of the lowest bed, which should repose on sand and be concealed, is brought to light, and may be distinguished by its peculiar fossils.

So likewise to the East of Bath, as we ascend the hill towards Hampton Down, we pass over several visible subsidences of the bastard free-stone, and, proceeding in the same direction, when we have passed the summit of the hill, and descend towards the canal by the rail road, where the cliff appears, we count five depressions of this rock, with its sand bed, and at a lower level we find the blue marl, on which the river glides, and in the marl we find its peculiar rock. This subsidence of the bastard free-stone continues all the way to the Dundas aqueduct, and in it the canal is formed.

South of this line, in the road from Widcombe to Claverton, we observe this rock has fallen down to a considerable depth, leaving chasms now occupied by clay and gravel. Here also we find ponderous masses, which dip into the hill.

Near Bath, our most remarkable dislocation of the bastard free-stone is on Mount Sion, where the summit of the rock is visible. From this elevated region, looking down upon all the hills by which Bath is immediately surrounded, we command, in the distant offscape, a view of Mendip. On this delightful spot, Dr. Parry has made extensive excavations, for the foundation of his magnificent structure, and exposed numerous dislocated fragments of the rock. At a lower level, in the hollow way by which carriages will ascend to this high hill, he has sunk (A. D. 1811) pits to a very considerable depth. These exhibit enormous blocks heaped up confusedly, some much inclined to the horizon, others nearly vertical, and falling headlong into the vale, through which the river flows.

Beneath this chaos we have the blue marl bed, which may be traced on the same high level, by Park-street to Camden Place, and from thence to Bath Easton.

To the South of Bath, under Beechen Cliff, the same marl appears, with its rock and springs: but in the intermediate space, between Mount Beacon and this cliff, the bastard free-stone, with its marl bed, has sunk down to such a depth, that the former is quarried near Widcombe Crescent, in the road to Claverton, and the latter is to be seen fifteen feet under sand, in the well of Caroline Buildings, that is nearly on a level with the river. By Hetlin Court, when the hot springs had failed to supply the usual quantity of water in a given time, the Corporation employed Mr. William Smith to remedy the evil. He laid open the ground, detected the cause of failure, and restored the springs. At that time I took notice of his operations, and at a great depth saw the springs issuing through the blue marl.

Subsequent to this operation, Mr. Palmer, then Mayor, sunk in the sand of the King's bath, as deep as he could venture to proceed, without endangering the pump-room, yet he did not arrive at the blue marl. From the bottom of his sinking he sent me a quantity of sand. This was alluvial, not calcareous, but silicious, and in this sand I discerned the green quartz, with iron, such as we find beneath our chalk, in Wiltshire, and from thence it came.

Extensive portions of the bastard free-stone bed, disrupted and fallen down below their native level, may be observed in Collier's Lane, going up to Lansdown. But should any young geologist, occasionally resident, or a transient visitor in Bath, wish to see some dislocation of this rock, without extending his walk to Collier's Lane, or climbing the steep ascent to Claverton and Hampton, he may easily gratify his curiosity by walking on the canal bank to the boundary of Bathwick, and then crossing the Folly bridge to examine at his leisure the five successive depressions of the rock, which form as many steep ridges. At the foot of each, thus placed on different levels, the marl springs issue, always following the dislocations of the rock.

The same appearances have been noticed in numerous places, but are no where so distinctly seen as in the immediate vicinity of Bath. Indeed no country can exhibit more interesting scenes for the geologist, or more numerous examples of dislocation, than this; for here, not merely the bastard free-stone, but all the strata, disrupted to a great extent, have fallen down towards the subjacent vallies, and after reiterated fractures, forming steps, have sent down enormous blocks, which are either piled up in heaps, or scattered on the declivities. These phœnomena are striking; but near Bath we have others abundantly more so. To the South of Prior Park, on the Southern hanging of Coombe Down, where we look down on the wide expanse in which a little streamlet flows, we find the bottom bed of the great free-stone rock, and, to the East of this we have, nearly on the same horizontal level, the superior beds of the same rock.

At Bradford, the whole of the great free-stone rock has sunk with the superior strata, of the forest marble, of the calcareous grit, and of the corn brash rocks; all the covering beds, except the white clay, have disappeared, and have left thereby a free passage for the Kennet and Avon Canal to pass this high ridge of land.

Contiguous to this, and immediately to the South of it, the same rocks rise up again and form elevated cliffs.

Between Newberry Hill, or rather Buckland Down, and Elm, the whole of the great oolite rock has vanished, with its subjacent clay, marl, and fullers' earth, to appear no more in the South East, which is the direction of its dip; and in consequence of this, the subjacent rock of bastard free-stone is brought to view.

At Midsummer Norton and Chewton Mendip, both the great oolite and the bastard free-stone are gone, and the forest marble is seen resting on the lyas beds. At Murdicombe Bridge, in Vallis Bottom, and in the Coombes, near Mells, the bastard free-stone bed shows itself on the smooth surface of the mountain lime-stone, without the intervention of the lyas.

In the quarries at the summit of Anthony Hill, near Bath, we meet with a very interesting dislocation. Here are seen only the bottom beds of the great oolite rock, which are, to use the provincial terms—1. A bed of rubble, called riddance, six feet; 2. Beds of ragstone, composed of broken and agglutinated shells, nearly horizontal, twenty-one feet in thickness, lying perfectly flat on a smooth face of the subjacent beds; 3. Prime stuff, or pure oolite, with its beds dipping South West, in an angle of 45 degrees, twenty feet in thickness. Its beds are all truncated at the upper surface, in one straight feather edge, and the whole mass lies with a smooth truncated face on a bed of rag-stone, which, like the upper rag-stone, is nearly horizontal.

The whole is calcareous, and the several beds serve for various purposes of building houses and walls, or for mending roads.

The same dipping beds, enclosed between the two horizontal beds, are to be seen at Burnthouse gate, and above Swanswick, on the Gloucester road. But that which is still more remarkable, is to find, as at Buckland Point, in the parish of Mells, rhomboidal beds of the rag-stone of the great oolite truncated, perfectly smooth in the superior and inferior surfaces, dipping South East 40°, and confined between two horizontal beds of clay, of which the uppermost is yellow, and the undermost is blue. We can scarcely conceive that such dipping beds were ever horizontal, as the laminæ make it probable they were. If they were once horizontal, in what state or condition were they when this dislocation, producing their angular position, took place? Were they soft? Why then did they not subside, and again assume an horizontal position? Were they indurated? By what agent then were the horizontal sections made, so as to leave a flat, rhomboidal, and perfectly smooth surface, incumbent on, and covered by soft beds of clay?

Should we be able to resolve these difficulties, we might then understand how it came to pass, that in the parish of Mells, as stated above, the bastard free-stone rock every where lies on a perfectly flat and horizontal face of mountain lime-stone, which, in Vallis Bottom, as stated above, appears in regular beds of equal thickness, dipping

North West. Dr. Hutton met with something similar to this at Jedburgh, where the horizontal strata are incumbent on a flat face of vertical schist, for which appearance he could give no probable account, because neither rivers, winds, nor tides, can produce such effects. His expedient of raising these beds above the surface of the ocean, and then sinking them again, has not sufficient evidence for its support. All his concomitant facts tend to prove, that the operation in question was performed at the bottom of the ocean.*

North of Radstock, the bastard free-stone rests on the red ground, without the appearance of either the lyas or its blue marl. At Chard and at Castle Cary, we have the lyas within a quarter of a mile of chalk, and near Mells, we see the mountain lime-stone within about one mile of the chalk hills.

From the dislocated crop of the great oolite on Lansdown, we look down on a very extensive vale, which runs S. W. and N. E. in the direction of the strata. The same circumstances obtain at Murhill, on a more contracted scale. But on the margins of Farley, Hampton, and Claverton Downs, which are separated by a deep valley, and by the Avon, beautiful sections of this rock appear, nearly at right angles to the range of its strata, and the fragments at their base form extensive aprons, which hide the bastard free-stone.

In these coombes and vallies, the angles correspond, the salient to the entrant. Yet we must not hence entertain the notion, that the corresponding margins were contiguous, till they were rent asunder by some sudden and violent convulsion. No: in this country it is clear, that the separation, however originally made, has been perfected by attrition, and the intermediate portions of the strata have been scattered both along the gorges of these hills, and beyond the terminations of their vallies.

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* See his vol. I. p. 432.

This, however, is not the only proof of erosion, for horizontal sulci are visible in the cliffs of Hampton and Farley Downs. It is particularly worthy of attention on the edge of Hampton Down, where the strata appear in elevated cliffs, and where some of the beds project, that not only they, but other beds, protected by them from rain, are equally eroded, and discover the same depth of furrows. Nay some of these, and little basins contiguous to them, contain broken sea shells, and quartz shingle, such as have no connection with this rock. Similar basins with shingle have been noticed in the elevated lime-stone cliffs of the Usk and Wye.

The correspondent cliffs on the edge of Farley Down are not merely fretted horizontally, but seem to have been perforated by the pholas. These cliffs are about five hundred feet above the bed of the river which flows between them, and their horizontal distance from each other is apparently more than three quarters of a mile.

The dip of strata, which must originally have been horizontal, is in itself a sufficient evidence of dislocation. Of their dip I have already treated; and of their extraneous fossils, which, by their position, demonstrate that the beds were horizontal at the time of their formation, I shall immediately proceed to treat. Suffice it then to observe in general, that even in strata which are now vertical, ponderous bodies and fragments of shells, lying flat in the direction of the strata, prove that they subsided horizontally in the bosom of the ocean.

In Scotland, Ben Nevis rises four thousand three hundred and fifty feet above the level of the sea, and dips toward Loch Linhe; but to the N. E. it is precipitous, and exhibits one face, which rises almost perpendicular fifteen hundred feet.

In Salisbury Craigs, near Edinburgh, we observe a mountain cut almost perpendicularly, as with a knife, from top to bottom, and half of this stupendous mass has disappeared. Something similar to this I observed near Valence, in the South of France, where a vast mountain has been rent asunder, and has not retained the smallest vestige of the half which it has lost.* Such facts surely do not indicate a slow and successive detritus, by the usual agents of destruction, rain, dew, sun, frost, and wind. They point our attention to some more powerful instrument of dislocation, and will hereafter lead us to inquire what that power may be. The same observation will apply to Chedder cliffs, which rise to the height of three hundred and forty-two feet, and are in some places absolutely perpendicular. This fissure extends about two miles, without the least vestige of either river, brook, or springs. But in descending through this stupendous pass, no sooner do you reach the village than you behold springs breaking out abundantly; and within a hundred yards of the cliff, rushing from beneath the rock, they turn several mills.

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* See my Travels, vol. I. p. 60.

Most of the Coombes round Bath discover, as we have already seen, fractured strata, extensive chasms, wide gullies, and enormous tumblers. These are particularly striking in the quarries on Combe Down, in Kingsdown Hill, at Box, which is on the Western ridge of Kingsdown, and in the new road to Bradford, where the fractured strata have been depressed, and their correspondent portions have been separated from each other to the distance of many feet.

Such dislocations as these last mentioned are extremely common, and have been occasioned by the removal of sub-strata; but the chasm at Chedder cliff, and numerous others, evidently mark convulsion. Thus for instance, nearer home, and upon a more contracted scale, we know that Bath and Radstock are upon the same drift line of the strata; consequently they might be naturally considered as on the same horizontal level. But the latter is, in fact, one hundred and thirty-eight feet above the former, and, as the lyas beds appear in both, these must have been either raised to the South of Radstock, or depressed at Bath.

Again, when a person conversant with strata, visits the quarries at Twiverton, Corston, and Ashton Hill, and proceeds in the same direction all the way on the back of the lyas, to the elevated lands near Chewton Keynsham, whence he looks down on the lyas beds at Bitton, which, from their range, should have been on the same level; it will be impossible for him not to see that some dislocation has taken place, either by lifting up the country South of the Avon, or by the subsidence of the strata to the North of it, or perhaps by both.

As he returns from this high land to Newton, he may easily trace the dislocation, and round the church it becomes most visible.

Newton church stands on the crop of the lyas, and in a garden, South of the church, is a quarry on the lyas beds, which dip very fast to the South. These are naked and exposed in Sweet Water Lane. Immediately North of the church the lyas is wanting, and in its place we find the red ground. From hence we look down on Kelston House, which stands proudly on the margin of the lyas cliff, whose foot is washed by the waters of the Avon.

These circumstances sufficiently evince a dislocation; but, North of the Avon, the same is demonstrated by *inversion of the dip;* for there the strata fall towards the Severn.

It is highly worthy of our notice, that South of the Severn, in Somersetshire, all the coal strata are depressed, and lie deep; whilst to the North of that river, in Monmouthshire and the Forest of Dean, they are equally raised above the level of the sea.

Eastward of the Wye, in Gloucestershire, both sides of the Severn are nearly on the same horizontal level.

The boldest crops I ever saw, the most stupendous, or certainly among the most stupendous that can be seen, are in Switzerland and Savoy. Near Geneva the strata look toward the lake, as may be observed in Mount Saleve, the Mole, the Brezon, and Vergi, whose scarps are elevated, and are in some places perpendicular. These are separated by vallies, running N. E. and S. W. But beyond these all the chains, as far almost as Mont Blanc, look towards the central Alps, and as they approach their sovereign they raise their heads, and stand almost erect, so as to form precipices, some of which rise to the height of three hundred feet.

North of Jura the chains gradually sink, till they die away in Burgundy, and the Bishoprick of Basle. Of these chains instances are found, in which two, inclosing a vale between them, have their scarps turned to each other, with corresponding strata, such as indicate, that they were once united, and that either the intermediate part has been destroyed, or the sides have been rent asunder, to make way for the vale, which they inclose.

Near the plains of Franche Compté, all the chains turn their scarps to the N. W. and sink gently to the E. S. E. till in the plains they become nearly horizontal.

South of the central Alpine chain is another, called *Rintor*, all whose secondary chains, as far as Cramont, turn their backs upon the North, and look towards Italy.

Cramont itself is lime-stone, with mica, and rises eight thousand feet above the level of the sea.*

Saussure, at first view, conceived the *summit* of Mont Blanc to be composed of foliated rock, applied round an axis like the leaves of an artichoke; but he was afterwards convinced, that the plates of granite are perfectly parallel to each other.

He informs us, that in the central chain the strata are vertical, and homogeneous from their base to their summit, and that all the other peaks resemble this.

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* Saussure, § 345.

The secondary strata are nearly vertical in the line of their junction with the granite, but approach an horizontal position, in proportion as they recede from it.

After what he and Mr. De Luc have said upon the subject, there can be little room to doubt of the granite having obeyed the laws of the superjacent schist, that it is stratified, and that it was formed by subsidence: in short, that, once horizontal, it has been rendered vertical by dislocation. Indeed, the whole of the Alpine region, considered as one mass, shews the most evident marks of dislocation. On the North, all the exterior chains are composed of calcareous mountains, high and extensive, yet gradually declining from the most elevated peaks of Switzerland, which rise more than fifteen thousand feet above the level of the sea, to the more humble tumuli of Dauphiné. On the South, schistous rocks prevail, nay even granite reaches to the plains; and the highest scarps of the central chain, turned towards Italy, form a wall of enormous altitude, from which you look down on a sheltered, fertile, and well-watered country, extending to the South. In approaching from the North, were all the intermediate vallies filled, the ascent from Dauphiné to Mount Blanc would be extremely easy, and almost insensible.*

In Russia and Siberia, the same phœnomena appear.†

The dislocations above described are visible to every eye.

In *collieries* we meet with dislocations, of which no vestige is to be seen upon the surface. These, in Somersetshire, are called *traps;*

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* v. Saussure and De Luc.

† v. Professor Pallas.

in other parts of the kingdom they are known by the name of *faults.*

At Newton, in the immediate vicinity of Bath, where, for more than half a century, trials have been made for coal, and much coal has been raised, so numerous and perplexing are the faults, that many pits have been abandoned. Here, indeed, sufficient evidence to check the spirit of adventure is visible to every one, who is acquainted with the superincumbent strata. But at Kingswood, where the coal exhibits every species of dislocation, nothing is noticed on the surface to excite suspicion.

The collieries of Camerton and Radstock have the same beds, but are in different vallies, which are about two miles asunder, and are watered, each by its own stream. Between these collieries there is a fault of four hundred and twenty feet, and to the N. E. of Radstock is another fault, which, for many years baffled the researches of the most experienced colliers at Writhlington, till the adventurers had spent thirty thousand pounds, and after this expenditure happened to sink a pit at a considerable distance from their former workings to the S. W. and there found the coal seam to the Westward of the fault.

When I paid a visit to Mr. Paget, at Newberry, two miles South of Radstock, in the vicinity of the mountain lime-stone; he made me notice two striking faults near to his own house. For here, in proceeding towards the East, the coal beds are cut off by a great fault, which, running N. and S. occasions them to sink twelve hundred feet, but, at the distance of about six hundred yards, they rise again and observe their proper course.

One mile to the South of Newberry is Coleford, South of which the coal approaches very near to the Mendip mountains of limestone, which form a barrier to resist its further extension to the South. In this district, they count fifty considerable beds of coal, cropping out one after another, in a contracted valley, which, from E. to W. is six miles in length, and from N. to S. is two miles wide. Of these coal beds, all which occupy the Southern range, dip to the North in their Western portion, become vertical in the middle of their course, and, as they proceed towards the East, change their dip and fall towards the South. Thus their order of succession is inverted; the most shallow become the deepest beds, and the schist, which to the Westward formed the roof, becomes the floor in the Eastern district of this range.

As we return towards the North, and visit the collieries of Farrington, High Littleton, Clutton, and Stowey, we find them exceedingly deranged by faults.

In all the coal fields of the districts to the E. and W. of the Severn, colliers make the same complaints of faults. In Staffordshire these occur of all dimensions, from a few inches to three hundred feet.*

Derbyshire is extremely rent, and the collieries abound with dislocations.

The strata in the vicinity of Ecton, Dovedale, Ham, and Swithamly, are in the utmost confusion, and the coal is in some places lifted up, or thrown down three hundred and sixty feet. To Whitehurst and Pilkington we are indebted for this information. But were it not for the laborious researches of Mr. Farey, we should know little of Derbyshire. We have, indeed, been long since acquainted with the four beds of lime-stone, as they appear in the lead mines, separated by three beds of toad-stone; but, before Mr. Farey made his survey, we had not any adequate information respecting the extent to which these beds were dislocated. To him we must ascribe the whole merit of having detected the intricate windings of these faults, by which four extensive districts have apparently been elevated above the level of the surrounding country.

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* Shaw's Staffordshire.

The great Derbyshire fault, extending E. and W. has been distinctly traced from Nottingham, through Derbyshire, to the Weaver Hills, in Staffordshire. With this principal fault many others are connected, and two of these have more especially attracted attention. The first is the Zigzag fault, which, as Mr. Farey has clearly ascertained, stretches between Allestry, in Derbyshire, and Dinnington, in Yorkshire. This divides the coal measure to the East and West of it.

The other is known by the name of *The great lime-stone fault*, which appears at Cromford, and proceeds by Wirksworth to Wooton, where it joins the great Derbyshire fault, as far as Ramsor, and then turning Northward, has been traced by Buxton to Castleton, Bradwell, Great Hucklow, Tideswell, and Litton. Now, if from Cromford we follow this great fault toward the West; in the short space between this town and Hopton, we shall meet with in succession the three uppermost lime-stone beds, and their intervening toad-stone beds, then the fourth, or lowest lime-stone bed, which abuts against this fault all the way through Staffordshire to Castleton.

This fault occasions the last-mentioned, that is, the lowest of the lime-stone beds, to abut against, and even to make a very high hill above the red ground, exhibiting thus, in the short distance from Ramsor to the Weaver Hills, a rise of four or five hundred yards. The toad-stone beds here enable us to measure this rise, and to demonstrate, that these beds conform to the general dip, and incline towards the South East.

It is here most worthy of our notice, that both the most numerous, and most productive lead mines are in the first lime-stone bed, and that the principal veins extend through the whole series of these beds, but not without interruption, for the three toad-stone beds are very rarely broken through, consequently they must have been introduced subsequently to the formation of the veins, which event, like the faults, implies wonderful dislocation of the lime-stone in this part of Derbyshire.

It is likewise worthy of remark, that the *warm baths* of *Buxton* are on this great lime-stone fault, and close to that bed of the mountain lime-stone which, although lowest in the series, is here most elevated.

Till we approach this accumulation of faults, the strata, all the way from the sea coast of Essex, follow in succession, as we have reason to expect they should do, and rise very gradually in a North Westernly direction, from the great bed of clay to the crops of the chalk, of the sand, and of all the lime-stone beds, with the subjacent red ground strata, which cover the coal beds. For when we leave the lyas to the South East of the Trent, and the red ground with the coal measures to the North West of that river, and arrive at the great lime-stone fault, the bottom bed of the mountain lime-stone rises up towards the peak, and to the elevated ridge which forms the Eastern boundary of Cheshire.

The great lime-stone fault between Ramsor and Wetton, has numerous swallow holes, close on its Eastern margin, into which all the rills of water, with some considerable rivers, precipitate themselves. Mr. Farey enumerates twenty-eight such swallows; and he informs us, that near *Buxton* he observed a gulph, one mile long and a quarter of a mile wide, surrounded by swallows in the fourth bed of lime-stone.

Similar swallow holes abound on the Mendip hills, which, in all respects, resemble those of Derbyshire.

The principal faults of the Newcastle coal field have been accurately traced, and are well ascertained.

Two miles North of Newcastle, one great dyke, or fault, throws down the coal five hundred and forty feet. By means of this, the high main coal seam, which crops out to the South of the dyke, is preserved, and spreads over a very extensive tract of country, still rising to the North till, at the distance of three miles, it is cut off, and thrown down again two hundred and forty feet. Between the Tyne and the Wear Rivers, there is another fault, dividing the Sheriff Hill colliery into two parts.

Eastward of the River Team, the high main coal crops out, and does not appear between that river and the Derwent. But about six miles West of Newcastle, some collieries have been established on it. These dykes change the species of the coal, as I have already stated. With the nature of these dykes I am unacquainted. Are they filled with fragments? Are they toad-stone? Are they basalt? or of what specific substance are they composed?—These are questions I am not prepared to answer. My object here is simply to point out dislocation, reserving the causes of dislocation for a subsequent discussion.

In the collieries at *Lansamlet*, near Swansea, in Glamorganshire, my father was unremittingly employed for nearly thirty years, in pursuit of a vein which he had lost. It had been worked, for years, from the crop in Crymlyn Bog, near Britton Ferry; but in proceeding Westward, they met with a great fault, many fathoms in thickness, filled with fragments of disrupted strata, and running nearly North and South. Beyond this they sunk numerous pits to a considerable depth, but in vain; for this being a rise fault of above two hundred and forty feet, threw the vein, called the *Llanvern*, and other attendant veins, both above it and below it, completely out of ground: My father then made repeated trials to the Eastward, and was at last successful, and laid open one of the best collieries in Wales.

The faults in this part of the coal field are numerous and extensive, and range from North to South.

Among the most remarkable dislocations in collieries, may be reckoned those referred to by Dr. Millar, in the second volume of his edition of William's Natural History of the Mineral Kingdom, page 572, at Quarrelton colliery, in Renfrewshire, and at Anzin, near Valenciennes.

Somewhat similar to these are the dislocations mentioned by Saussure, in his account of the Alps, for he has particularly noticed several mountains, in which the strata resemble the roof of a house. Others form a parabola, but become horizontal in the vallies. Others resemble our letters C. S. and Z. or even the Greek lamda λ. Others again are perpendicular, inclosed between strata, which, like the former, resemble the roof of a house, as if they had been lifted up by the subjacent perpendicular strata. Similar dislocations have taken place in collieries.

A vertical section of the schist, on the sea coast near Sir James Hall's, is most remarkable, because it exhibits alternate elevations and depressions without rupture, resembling the inflexions of a serpent.

At Newcastle the principal fault, which I have noticed above, runs for near twenty miles in the same direction with our great rivers, that is, N. E. and S. W. and, although it separates the disrupted strata more than five hundred feet, yet on the surface, the country is so level as to discover no mark of dislocation.

There is no colliery of any considerable extent in the whole island, but what exhibits marks of similar disruptions. Yet in all these *faults*, the corresponding portions are as regular, in the succession of their dislocated strata, as the leaves and cover of a book would be, if they were bisected and placed in different plains.

Deep water in *lakes*, and in the ocean near mountainous coasts, may be considered as produced by dislocation; as, for instance, the

Lake of Geneva, but more especially the Caspian Sea, which, near the shore, bordering on Alpine mountains, is at least four hundred and fifty fathom in depth.

On the Western coast of America, where the mountains of the Andes rise to a stupendous height, even within a cable's length of the shore, in many places our mariners can find no soundings, and in general it has been remarked, that near the most elevated mountains, the ocean is proportionably deep: but on a flat coast the waters are extremely shallow. This we remark on the Eastern shore of America, whereas on the coast of Norway, where mountains rise, the extensive creeks are from one to four hundred fathoms deep, and in some places no bottom can be found.*

So likewise on the Eastern coasts of Asia, Tartary has the most lofty granitic mountains and deep seas, for in latitude 44°, at two leagues from the land, La Perouse found one hundred and forty fathom of water, whereas on the flat coast of China, in latitude 31°, at the distance of thirty leagues from land, he had only twenty-five fathom water.

I have noticed the fissures in coal mines, by the provincial names of *faults* and *traps*.

These commonly are filled with fragments of the rocks, between which the coal beds lie. But in mineral regions, the fissures usually contain heterogeneous matter, either metallic, calcareous, argillaceous, or silicious, and are denominated, in some parts of England, *veins;*

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* Pontopidan's Norway.

in Cornwall, lodes; in France, gangue; in Germany, gänge. Of these, some originated in exsiccation, but many shew marks of violence. The most remarkable *veins*, of which I have collected accounts, are, one in the valley of Lawterbrun, in the Alps, one hundred and forty feet wide, filled with calcareous spar; the second in the island of Arran, filled with porphyry, one hundred and sixty feet wide; and third, the veins of Rammelberg, near Goslar, on the confines of the Hartz. These are two in number, and are from one hundred and eight to one hundred and twenty feet wide, of unknown extent, and, although originally vertical, as they must have been, now make, in different directions, the one an angle of 25°, the other an angle of 45°, so as to meet below the surface, and cross.

The deepest mine at present known, is in Bohemia. It is three thousand feet deep.

When veins meet together, they shew evident marks of dislocation, and in Cornwall are said to *heave* the lode, where it is diverted from its course. This may be accomplished in two several ways, perfectly distinct, for it may be heaved either up or down, and either to the right hand or to the left. Hence it is, that we hear of *cross gozans*, and *course gozans*. For supposing a vein to run East and West, and a fissure running North and South to be filled with gozan, this will be called a cross gozan. But should the fissure thus filled, run like the metallic vein from East to West, it would be denominated a course gozan. By *gozan* is meant a vein, or lode of loose and friable quartz, impregnated with iron ochre. Such lodes, when they run East and West, usually carry much iron on their superior portion, or, as the Cornish miners express it, on their *back*, and become copper lodes, as they descend. Their dip being opposite to that of tin lodes, both lodes meet in depth; and when this happens, the tin lode never fails to be broken and turned aside, that is, *heaved*, by the copper lode.

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* De Luc.

I do not recollect to have seen a cross gozan productive of copper.

Polgooth, the most considerable tin mine I ever visited in Cornwall, is remarkable, as being six feet wide, and extending East and West for more than one mile. This mine dips North, and has been pursued to the depth of near a thousand feet. This lode, to the East, is split, and to the West is interrupted by a cross course, which dips East.

In the parish of St. Agnes, in Cornwall, was a tin mine, dipping to the North, which enriched many families, and laid the foundation of extensive fortunes. After much wealth had been collected from this mine, it suddenly failed, being cut off by a course gozan, and was abandoned. This was in the infancy of mining. Some years after, when by experience it had been discovered, that a gozan could heave a lode, but could not destroy it, another set of adventurers sunk a shaft to the North of the last workings, cut through a second gozan, and found the lode, which had been heaved up more than one hundred and thirty feet, by the two gozans. In depth they met with a third gozan, which heaved the lode nine feet. These discoveries gave occasion to a third set of adventurers, who, sinking a shaft on that part of the lode contained between the two great gozans, met with ample payment for their sagacity.

In St. Erth, one lode is heaved a hundred and fifty feet to the North.*

It frequently happens, that the gozan which has disturbed a tin lode, is itself disturbed and heaved by a fluckan, that is, by a vein of clay, which is frequently white and moist, and sometimes almost liquid, a quality well described by its provincial appellation, because *fliuch* in Celtic means wet, moist, and oozy.

Relistian tin mine, in Cornwall, runs East and West, and is about thirty-six feet thick in its widest extent, but to the East it is not more than five feet. It is composed of schist, chlorite, quartz, and tin.

The lode is heaved by a fluckan of about two inches in thickness. At the depth of seventy-five fathom, the fluckan was four inches thick, but sinking ten fathom deeper, they found it separated into four diverging branches, intersected by a mass of shingle, that is, rounded gravel, such as we find on the sea beach, but composed of chlorite schist, cemented by tin crystals. This mass again was surrounded by scattered bunches and single stones, of the same materials, for several fathoms, both above it and below it.

I remember to have seen a copper lode in the parish of Camborn, bisected by a fluckan of thirty or forty feet, to the East of which the ore was grey, and the quantity of iron ochre so abundant, from the surface to the depth of one hundred and fifty fathom, that the garments of all the miners were perfectly red, whilst to the West the ore was yellow, without a vestige of iron to be discerned. In the parish of Redruth there is a remarkable tin mine, called Wheal Pewer, in which the lode is heaved many fathom, by a course gozan, rich in copper, and both these lodes are heaved again by a fluckan, which makes a more acute angle with the horizon than the copper course, and throws down sixteen fathom of the tin lode many yards below the portion to which it had belonged.

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* *v.* Borlace.

These three dislocations must have taken place at different, and at distant epochs.

Here an observation of Borlace is highly worthy of our notice—He remarks, that lodes, being perpendicular to the strata, and therefore liable to be dislocated, incline towards vallies, and in Cornwall dip towards the greatest subsidence.*

Among the substances which occupy our fissures, the most strikingly remarkable is *granite;* because this rock was conceived to have been absolutely primitive. The first person, as I imagine, who detected granitic veins, was M. Saussure. In the valley of Valorsine, he found hornstone schist, crossed at right angles by a regular lode of granite, near three feet wide, and by others similar to this, but of less dimensions. He afterwards observed the same phœnomenon in Fort St. Jean, near the Saône at Lyons, where the foliated rock is cleft, and a vein of twenty-one inches is filled with granite.[*] This agrees with the discoveries of my old friend Besson, in France; and I may add, that veins of granite of new formation are found at Johangeorgenstadt, and of porphyry, at Marienberg.

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* v. Borlace Nat. Hist. of Cornwall.

We must not here overlook the *basalt*, whether interposed between strata, or as *veins*, bisecting and dislocating all other veins, although it is itself disturbed by none. It has been particularly noticed by Dr. Marshall, that the fractures of such veins do not cross them, but run parallel to their sides.

In the North of Scotland, and in the Shetland Islands, between the lime-stone and the granite, veins of basalt are abundant, and some, to the thickness of thirty feet, traverse all the strata, and even penetrate the granite.[†]

In Strathmore is, what is there called, a *dyke* of *whinstone*, more than seventy-two feet thick, which runs East and West between twenty and thirty miles. On the coast of Air, to the North of Irvine, there have been observed, in the space of about twenty miles, twenty or thirty of such dykes, of great thickness, which are united to other cross dykes. It is said that some dykes have been found six hundred feet deep.

In the Island of Mull are two fissures in the granite, one nearly filled with lava, the other not far from it, ten feet wide, one hundred and twenty feet deep, yet empty; excepting only, that near the top two stones of granite are jammed in, and suspended in the chasm.

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[*] Saussure Voyages, § 601.

[†] Jameson's Shetland.

Professor Pallas, in the account of his travels through the Southern provinces of the Russian empire, has indulged us with some most interesting views, attended by accurate descriptions. Among them we find two of grey granite rocks, on the banks of the Berda rivulet. The first presents soft and lamellated granite, in beds of various thickness, waved, interrupted to the S. W. and intersected by transverse clefts, with parallel beds of coarse grained red granite, intersected by similar clefts.

The second has a stratum of schistous granite, richly micaceous, separating solid grey granite from red compact granite.

In a tract of about twenty fathoms wide, he observed seven different species of granite, disposed in beds.* All these prove dislocation, and point our attention to distinct, or even distant epochs.

With regard to *lodes*, that is, metallic veins, we may venture to receive the subsequent as general laws.

1. In each mineral district, the direction and dip of the several lodes, carrying the same kind of substance, have a strict conformity.

2. The several metals are confined, in great measure, to their own peculiar rocks. Thus, granite carries lodes of tin, tungsten, wolfram, and molybdena, with native gold and silver, and some copper pyrites; it contains also iron and bismuth.

Argillaceous schist has tin, silver, copper, lead, iron, with nickel and bismuth.

Calcareous rock has cinnabar.

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* Vol. I. p. 520

Mountain lime-stone is highly favourable to copper, lead, zink, manganese, and iron.

3. Veins were originally vertical fissures, which become narrower as they descend.

4. Their opposite sides, however numerous the layers, correspond. The first deposit was on the walls, and the last in the middle of the vein.

5. The mineral solution confined within the fissures, being undisturbed, deposited its precipitate in such a state of tranquillity, as to admit of crystallization.

6. The fissures were filled from above. This is made apparent by the shingle in Relistian tin mine, already mentioned, and by the granite stones suspended in a fissure, as stated above; by the shingle observed in Dauphiné, by the bivalves of Schemnitz, and by the Madreporites which Baron Born has noticed in Hungary.*

7. Most of the mineral substances which form veins, are found also in beds, or floats.

8. Veins of the substance of a superior rock may penetrate the inferior; but the reverse of this, no person, as yet, has been able to demonstrate. Thus, for instance, veins of gneiss penetrate the subjacent granite; but no veins of granite have been observed shooting from the mass of granite into the superincumbent gneiss.

In some of the Cornish mines I have observed a great abundance of virgin copper, and in Wheal Virgin I found *breccia*, entangled in its ramifications. The specimens now in my cabinet, contain pellucid quartz crystals, and fragments both of white quartz and of jasper, whose edges are acute, scattered with the utmost irregularity, some distant from each other, some closely bound together by the copper.

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* *v.* Werner on Veins.

CAVERNS, every where abounding in mountain lime-stone, carry with them unequivocal signs of dislocation.

The most remarkable of these, in the vicinity of Bath, are on Mendip hills, particularly in Chedder cliff. Wooky hole extends six hundred feet in the rock, and emits a copious stream, sufficient to turn a mill. Kentshole, a cavern similar to the preceding, at Torquay, has been penetrated to the same extent. In Derbyshire, numerous stupendous caverns have been frequently described. Every one who has visited that country, has admired them in Peakshole, Poolehole, and Eldenhole, which extend more than two thousand feet. Similar to these, on a more contracted scale, are the numerous chasms already noticed, into which considerable streams of water fall, as they do in Mendip, to appear no more.

Near Caschau, in Hungary, the caverns are so extensive, that some members of the Royal Society, after remaining in them for three days, could not find their termination.*

On the Ural mountains, Professor Pallas discovered many caverns communicating to a vast extent. All these are in the lime-stone.

Among the proofs of dislocation, the ALPINE CHASMS, particularly noticed both by De Luc and by Saussure, must not be over-looked. They are abundant in granitic chains, and at the height of three thousand five hundred feet above the level of the sea, the latter met with one of a hundred feet wide, and so deep that he saw no bottom. All travellers on the Alps have regarded them with horror, and many hunters, whilst pursuing the chamois, have perished in these icy graves. They mark convulsion, and shew no signs of having been occasioned by attrition.

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* Townson's Hung. p. 317.

Some mountains of the Pyranees are equally stupendous with those of the Alps, buried in eternal snow. In the Eastern extremity, as I have particularly noticed in my Spanish Travels, the lime-stone is on the North, forming the rich country of the Rousillon, and the granite is to the South. But in Mont Perdu this order is reversed, and the granite forms a precipiece of near three thousand feet above the lime-stone.

But that which is most remarkable, is to see four enormous chasms, almost perpendicular, which divide both mountains and their vallies, and which appear as if they had just been rent asunder. From these lime-stone mountains, elevated some thousand feet above the level of the sea, you look down, to the South, on the most extensive plains of Arrogan. Similar to these are the chasms on Chimborazo, particularly noticed by Humboldt.

CATARACTS confirm this evidence. Not to mention those of the Nile, or those of the Cavery, which at Gungum Chouki fall two hundred and fifty-five feet, and numerous others in various quarters of the globe, I must particularly notice two. These are the great waterfalls of *Niagara;* because, from the wide expanse in which is Lake

Erie, you sink suddenly, and by an abrupt descent, two hundred and seventy feet, to the plain which is occupied by Lake Ontario; and the fall of Tequendama, in New Granada, which is six hundred feet. This we have confirmed by the authority of Humboldt.

In these situations the strata correspond, and are not composed of the detritus of more elevated rocks deposited by land floods.*

Again the practice adopted by the Cornish SHODERS, for the discovery of tin mines, brings to light numerous dislocations, and such as are highly interesting to the geologist. About forty years ago, I paid attention to the operations of a skilful artist in this line, who had been employed for many years by my brother-in-law, in seeking for tin courses. One day I found him engaged in the examination of a *shode-stone*, that is, of a stone somewhat rounded in its edges, which he had just picked up. He poised it in his hand, he spit upon it, and held it to the sun, that he might observe its change of colour by humidity. By this rude assay he was satisfied of its value, and resolved to find out the lode from which it came. After a few days I returned, and saw numerous pits at considerable distances, rising in succession one above the other, on a gentle declivity, near to each of which was deposited a little heap of stones. As he approached the summit of the hill, the pits were deeper, the stones were heavier, and their angles sharper. In the uppermost pit, Sampson Clemmow, for that was his name, perceived that he had passed beyond the mark, because he had no tin stones similar to that which had first attracted his attention, and which was abundant in the inferior pits. He did not, however, hesitate to say, that in less than two days he should be rewarded for his pains. The next day he cut the *broil* of the lode, which he immediately pursued, till it entered the solid rock. It must be here observed, that, by the *broil of the lode*, the Cornish miners understand that portion of a tin lode, which in its crop, that is, where it rises up to meet the day, forms a curve, bending towards the declivity. Here the lode, with its walls, and the rock itself, in which it is inclosed, are much shattered; but its fragments, sharp at the edges, shew no signs of attrition. In proportion to the distance from the solid rock, the shode is less abundant, and the fragments are dispersed more widely from each other. These circumstances universally occur, and point out a more powerful agent than rain, for this can never cause such kind of dislocation on gentle declivities, which have sunk below the limits, at which hills become quiescent, that is, the limits between the destructive influence of heavy showers and the unremitted accretion of vegetable soil.

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* Volney's America.

Estuaries, such as we may see in Dartmouth, Portlemouth, Plymouth, and Falmouth, exhibit evident marks of violent disruption and dislocation of the surrounding strata, for in these estuaries the multiplied creeks are so far from having been excavated by water, since the existence of our continents, that both the rivers and the tides contribute incessantly to fill them up in their extremities, and to choke them at their entrance. From this circumstance seaports, in various parts of the globe, which are recorded to have been enriched by commerce, are now deserted, and many which have not the benefit of navigable rivers, constantly require to be cleansed from their accumulating mud, sand, and gravel, in order to prevent their being closed.

ALLUVIAL STRATA, *Geschiebe* of the Germans, carry unequivocal marks of dislocation, such as may assist us to distinguish the various changes which at distant epochs have happened to our globe.

Immediately in the vicinity of Bath, we have numerous instances of these. In the Lock Pits at Wydcombe, near the river, we found in sinking—1. Vegetable earth, fifteen inches; 2. Yellow clay, five feet; 3. Blue marl, six feet, perfectly distinct from the former, and nearly horizontal; 4. A bed of gravel, composed of small fragments from the bastard free-stone rock, particularly from its coral bed. These were blended with the spoils of all the superior strata, through which the Avon passes. But that which is most remarkable, is to see, in this bottom bed, numerous fragments of the mountain limestone, and chert with the corals, fragments of the encrinus, and other fossils peculiar to this rock, all rounded at the edges. That these proceeded from Mendip is evident, because they are found in a similar situation all the way up the stream, at Hampton, at Stoke bridge, at the conflux of the Avon, with the Frome, which takes place near Winsley, but not in the Avon prior to the junction of these rivers. They have been likewise seen at Mitford Bridge, and have been traced all the way in the vale, through which the Frome directs its winding course, from Mells. Eastward of Bath, and South of Hampton, is a wide expanse of gravel, in which are scattered contributions from the Wiltshire Downs, and from the Mendip Hills.

This gravel bed is more than seventy feet above the level of the river. Its component parts may be readily distinguished, because the former of these spoils are flints, the latter mountain lime-stone. But at Monkton Farley, seventy feet above the Frome, the deposits are chiefly from Mendip.

Between Bath and Lambridge, a bed of this gravel has been opened, and is more than thirty feet in thickness.

Below Newton, in the wide expanse which gives a passage to the river, there is a vast accumulation of the same gravel as at Lambridge and at Hampton, with the addition of fragments from the lyas.

It is here to be particularly noticed, that the spoils from Mendip, which I have noticed at Wydcombe, are not found superficial, nor in either the blue marl or yellow clay. They are not therefore produced by the common detritus of rain; they are not rent from the rock by frost, nor brought down by torrents. The deposit was made at once, and has never been repeated.

In the several collieries at Newton, as I am told, when they approach the river, all is confusion, a succession of traps intervene, the coal is lost, and in its place are found alluvial strata. So likewise at Mells, as Mr. Fussell informs me, under the bed of the river, nothing but shingle is to be found to a very considerable depth. I well remember a coal mine of my father's, West of the Tave, or Tawe, near the town of Swansea, in which he attempted to drive under the river at the depth of many fathoms, but he was prevented by a bed of shingle and bowlder stones, which gave admission to such a quantity of water, as, had he persisted, must have drowned his colliery. Whitehurst has given us a similar description of the *Derwent* and its *bed*.

At the conflux of the two little streams, the Montets and the Arve, as described by Saussure in his Alpine journies, is a hill near four hundred feet high, composed of sand, gravel, and boulder-stones, mixed with clay, certainly alluvial, but not formed by these little streams. This naturalist, whose fame will never be eclipsed, was of opinion, that this high hill was caused by the conflux of currents; as in my Spanish travels, I have stated other similar alluvial congestions to have been produced.

In the alluvial gravel below Newton, not far from the river, several tusks, supposed to be of the mammouth, possibly of the elephant, have been discovered. One of these, measuring six feet, was in the possession of Jacob Wilkingson, Esq. At Brentford, near London, two teeth of the hippopotamus, and the entire tusk of an elephant, nine feet long, with other bones of the same animal, and several nautili, were dug up at the depth of thirty feet:

The facts before us agree with universal observation, for in every part of the globe, the gravel near to a river shows, even to a considerable depth, the strata of the country through which all the tributary streams now pass.

But what demands particular attention is, that the alluvial strata in question are not always mixed or blended together, but frequently disposed according to their specific gravity, which could not have been the case, had the dislocation of the strata, forming this deposit, been occasioned by that kind of detritus, which, in the succession of revolving ages, can be produced by rain.

This truth is rendered still more palpable by the tin beds of the stream works in Cornwall, particularly by those which have been established in estuaries, and at the mouth of rivers, as at Pentewan, Porth, Carnan, and Plymouth. In the great stream work of Pentewan as I noticed at the time, they met with the subsequent strata—1. Gravel, twelve feet to high water mark; 2. Peat, seven feet to low water mark; 3. Shells and granitic sand, eighteen feet; 4. Muddy peat and oyster shells, twelve feet; 5. Tin sand and shode, three feet; in all fifty-two feet, resting on a bed of argillaceous schist.

In the extensive work at Porth, near St. Austle, they had—1. Soil, six feet; 2. Peat, three feet; 3. Clay, eight feet; 4. Granitic sand, fourteen feet; 5. Clay, with oyster and cockle shells, ten feet; 6. Tin sand, covering tin nodules, three feet; in all forty-four feet under which came a bed of argillaceous schist.

Here we cannot look to rain and frost as the causes of dislocation, because the devastations of these destructive elements are gradual, and the deposits are successive. In this situation the whole accumulated mass, except the peat and vegetable soil, must have been collected at one epoch in deep water, because the tin subsided, and formed itself into one continuous floor; whereas ponderous metals, as for example gold, platina, and tin, when separated by rain or frost, and washed down by torrents from their native beds, are found mingled with the sands, and do not form a separate stratum by themselves. Precisely the same kind of tin shode, rounded at the edges, appears on a part of *St. Agnes' Beacon*, on the Northern coast of Cornwall, in regular strata of clay and sea sand, forming a bed of five feet in thickness, more than five hundred feet above the level of the sea, and not less than one hundred and fifty feet below the summit of the mountain.

Every part of the extensive moors of Bodmin, Roch, and St. Columb, which stretch Southward to St. Stephen's and St. Austle, has been rich in tin shode and gold, not deposited at the feet of mountains, but diffused over a vast tract of level country.

Dr. Robertson, in his American history, mentions a plain called Cineguilla, fourteen leagues in extent, in which, at the depth of sixteen inches, they found gold in large masses, and in such abundance, that a few men in a short time collected a thousand marcs, without washing.*

Such diffusion and subsidence of the most ponderous metal in large masses, was not caused by land floods. This operation must have been performed in the bosom of the ocean.

In the Isle of Wight, St. George's Down, one of its most elevated chalk hills, is covered deep with shingle, and on the hanging to the South are vast rocks of pudding-stone, all silicious. The same kind of accumulation is found on Martin's Hill and Chidbury, two of the highest hills, not merely of Wilts, but of the West of England, and on most of the chalk hills in every part of Europe, with which I am acquainted. These deposits of shingle are all under clay and sand.

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* Vol. 3, p. 231.

Whoever is acquainted with the external appearance, or with the internal structure of the country near Southampton, will see a striking example of dislocated shingle, transported from the chalk hills of Hampshire, and deposited in the elevated tract of land between its rivers, whose beds are too low for such an operation. The same observation will apply to all the accumulations of shingle I have noticed in every part of France and Spain.

Under the chalk we have seen three beds of sand. Now between these and the mountain lime-stone, we have particularly noticed eleven strata, besides coal. But between Exeter and Plymouth, and East of this line to Torbay, and more particularly on Little Haldon Hill, above Dawlish, we see the mountain lime-stone rock, covered first with lime-stone breccia, then with alluvial gravel of the same, and finally with the sand which belongs to the chalk, such precisely as on Blackdown, with the same species of agatized extraneous fossils, as we there admire.

In proceeding round our Eastern coast, at Boston, in Lincolnshire, we meet with a well, in which George Naylor sunk for water to the depth of near four hundred and eighty feet, altogether in alluvial strata, and in his progress five times met with chalk rubble. Here the trial was abandoned in despair, before he had penetrated to the solid beds, on which a constant supply of good water might have been obtained.*

We may remark, that a considerable part of Hertfordshire, and nearly the whole of Essex, is alluvial, and must be considered as composed of materials, which, in some distant period were contained in regular strata, whether calcareous, argillaceous, or silicious. Chalk indeed still remains unmoved on the shores of the Thames, West of Tilbury Fort, extending to Purfleet, and on the hills in the North East part of the country, as at Saffron Walden. The superior alluvial strata consist of either loam or gravel, and a mixture of chalk, clay, marl, and fragments of lime-stone schist, with flints on clay, to the depth of two hundred feet.

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* Phil. Trans. vol. 77, p. 50.

In the vicinity of London, particularly at Coombe Hill, Croomhurst, and Addington Hill, near Croydon, in Surrey, the beds of *shingle*, composed of flints mixed with quartz, are thirty or forty feet thick on the hills, and at a lower level this shingle forms a pudding-stone, in some places with a silicious, in others with a calcareous cement.

So likewise on all the summits of Chislehurst, Blackheath, and Shooter's Hill, we observe extensive beds of shingle. To the West of this, at Lumpet Hill, is a chalk pit of vast dimensions. In this spot, I observed immediately under the vegetable soil, six feet of silicious shingle, under which is a stratum of sand, eight feet thick, covering a bed of chalk rubble, sixty feet in thickness, with ten beds of nodulated black flint, all perfectly horizontal, and about six feet apart. Under this the chalk rock appears in horizontal beds, on which the springs break out so copiously, as to prevent the workmen from sinking deeper.

The whole of Lower Saxony and Holstein seems to be alluvial. Holland most undoubtedly is so: for in a well sunk A. D. 1605, at Amsterdam, to the depth of two hundred and thirty-two feet, they found shingle and pure sand, under alternating strata of sand and clay. And something similar has been observed near Brussels, but not to so great a depth. I here subjoin the particulars.

STRATA ABOUT BRUSSELS.

I. In a pit East of the valley. Vegetable earth, nine inches; clay, six feet; sandy marl, ten feet; yellow sand, eighteen feet; white sand, twelve inches; lime-stone, three inches; marl, three inches; lime-stone, six inches; sandy marl, two feet; lime-stone, three inches; marl, two feet and a half; lime-stone, four inches; marl, three feet and a half; lime-stone, four inches; marl, four feet; lime-stone, with fossil shells, four inches; white sand and springs.

II. In a well beyond Vee Weyde, in a valley. Vegetable earth and clay, about thirty feet; sand, twelve inches; sandy clay, nine feet; then water. But in no part of Flanders have they discovered more than one bed of vegetable earth.

Indeed the maritime parts of Flanders, like those of the united provinces, are perfectly alluvial, derived from the mountains, in which their rivers rise.

It has been suggested by some geologists, that England and France were once united. This supposition may be agreeable to truth, and granting this, but not in the way in which it has been understood, we can readily conceive, that the same mountains which furnished alluvial strata to the Netherlands, may have formed the coast of Essex, and contributed greatly to the elevation of our alluvial hills in Kent and Surrey.

All over the globe we find extensive plains formed by the spoils of lofty mountains; and even near the summits of the most elevated chains, we observe alluvial beds. Thus in the Ural mountains, as soon as we have ascended the high ridge in which all the rivers rise, which fall either into the Caspian Sea or the Frozen Ocean, and begin descending to the North, we meet with the bones of either the mammouth or of elephants, dispersed among marine productions.*

Professor Pallas, in his Southern journey, near Tzaritzin, which is one hundred and twenty-six feet above the Volga, saw fine clay covered by fullers' earth, with beds of sand and shingle, over which was beautiful white quartz. Proceeding thence towards Astracan, he found an hip bone and teeth of an elephant, and in the sandy hillocks he met with a jaw-bone of an elephant, much petrified and coated, both with mytilites and small gravel.

Humboldt found the teeth of the mammouth, and of elephants, on the plains of Santa Fé, one thousand eight hundred and ninety feet above the level of the sea, and he remarks—"Thus this animal appears from 50° North, to 50° South latitude, from the Ohio to Patagonia.

In China, it is evident that all the level country, with the immense plain, at the Western extremity of which Pekin stands, intersected by canals, and productive of petuntse, originated in deposits from the granitic mountains of the North.

The Carnatic, with all the country East of the Mysore and Coimbetore, through an extent of more than five hundred miles, is level and alluvial, with calcareous stones, containing sea shells; and Bengal seems to be so, for its two great rivers, the Ganges and the Burrampooter, are navigable, considerably more than thirteen hundred miles, and fall only one inch in a quarter of a mile. These rivers are perpetually shifting their beds, because they flow through an alluvial country. The Ganges wanders seven hundred and fifty miles among the mountains of Thibet, which rise twenty-five thousand feet above the level of the sea, then meanders one thousand three hundred and fifty miles through this level country, during the remainder of its course.*

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* Pallas Voyages, t. 2.

The distance from which such alluvial strata may have been derived, may be seen on a very contracted scale in our own little island. For, not here to mention Kent and Essex, the greatest part of South Devon, a mountain lime-stone district, has for its soil brown sand, diffused over the face of the country, which evidently came from beneath the great mass of chalk.

In all the alluvial districts here particularly noticed, it appears, that *only one bed of vegetable earth* is to be seen. Consequently these strata have not been produced by land floods, at different and at distant periods. They direct our attention to one epoch, and most distinctly give us a measure, by which to estimate the time which has elapsed since either the elevation of our present continents, or the depression of the surrounding seas.

The same observation will apply to all the strata of which I have taken a survey, from chalk to granite, in districts which are not alluvial, for throughout their whole extent, neither Hutton, Brydone, nor the Canon Recupero, could have found more than *one bed of vegetable earth.*

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* Asiatic Researches, vol. VI. and Major Rennell in Phil. Trans.

The BOWLDER-STONES of Bagshot Heath, but more especially of Middle Wilts, in Clatford Bottom, at Lockeridge, round Abury, and above all in Wroughton Bottom, shew dislocation.

These ponderous masses of granulated quartz, or sand-stone, in Wiltshire called sarsons and grey weathers, scattered over this elevated part of our island, occupy, not merely the vallies, where they are most abundant and appear by thousands, but even the summits of high hills, some wholly exposed to view, others partly or altogether covered by the bed of sand and clay on which they repose, and some, as in Pewsey Vale, buried twenty feet deep in marl, or a mixture of chalk, sand, and clay. Such are the enormous rocks which formerly constituted the pride of Abury, and are still admired at Stonehenge. Similar bowlder stones, in point of size and bluntness of their edges, I remarked in Spain, on the summits of the highest hills near Cordova, some of mountain lime-stone, some of silicious grit, and some of granite, all promiscuously scattered on the same plot of ground. This could not have been effected either by land floods or by the detritus of incessant rain, through endless generations. The same may be said of the alluvial strata, mentioned in my Spanish Travels, as being deposited on the high mountains near Guadix, between Granada and Carthagena, in which appear promiscuously, gravel and quartz schist, lime-stone, and flint, all rounded at the edges.

In *Devonshire*, between the two rivers the Otter and the Axe, are found vast blocks of hard chalk, charged with black flints. These have been noticed by the Rev. Mr. Polwhele, and particularly described in his most interesting travels by De Luc, who traced blocks of chalk scattered on the sea shore of Salcombe and Branscombe. It is indeed a wonderful phœnomenon to behold such blocks in the vicinity of granite, as at Widworthy. But the whole country round Exeter has been rent and dislocated to a most astonishing degree.

At Marychurch, beautiful marble is procured, and blocks of the same are found both in the vale beneath the cliffs, and on the beach.

From the description of Mr. Polwhele, I am inclined to think, that the bottom beds of the chalk are extended on the red ground even to the sea coast, and among my memoranda I find mention made of chalk recumbent on the lyas beds, on the coast at Axmouth.

Dislocation is strongly marked by the innumerable and most enormous *fragments of granitic rocks*, piled up or scattered over the most lofty hills of Devonshire and Cornwall, but more especially on Dartmoor. Such are likewise to be seen about Stafford, and near to Newport and Lawley, and at the base both of Caer Caradoc, that is, the Castle of Caractacus, and Ragheath in Shropshire.

Professor Wrede, of Berlin, was struck to such a degree by the assemblage of granitic blocks,* to the amount of many thousand millions, some more than sixty feet in circumference, and of various species, mingled at the mouth of the Oder, where no granitic chain is to be seen, that he published his observations on the subject, first in a Periodical Journal, and then, A. D. 1804, in a separate pamphlet.

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* Felstrummer.

He imagined, indeed, that these blocks, with the alluvial matters on which they rest, descended from some elevated region, by the impulse of torrents produced by the sudden melting of snow.

But this supposition is not founded on facts, nor is it agreeable to common observation, for neither rivers nor torrents remove such large and ponderous masses to a distant sea coast, much less to a coast which lies so flat as this does; nor have similar granitic masses been deposited in the intermediate space, between this vast assemblage and the mountains from which the Oder flows.

Such stupendous scenes of ruin, devastation, dislocation, and confusion, as Professor Wrede, with astonishment, beheld at the mouth of the Oder, were viewed with patient contemplation, and with a discerning eye, by our venerable sage De Luc, at the mouths of the Warnow, the Stor, the Eyder, and the Elbe.

He saw enormous blocks of granite, gneiss, porphyry, and jasper, such as no rivers could remove, scattered with profusion over the whole extent of country in Lower Saxony and Holstein. He took notice of their innumerable species, such as no one granitic chain has been known to yield. He examined the situation in which they are deposited, in districts now marshy, but once chiefly occupied by lakes and inlets of the sea; and, with more than common sagacity, assisted by a careful examination of the condition in which the lakes and inlets of the sea, existing at this time, are found, he has established the infallible chronometer, for the existence of our continent, which I shall notice in its place.

In these most interesting districts, many of the smaller lakes, completely occupied by peat, are now meadows; and the greater lakes, much contracted in their borders, discover islands, and evidently shew that they will progressively be filled. Many of these meadows, covered with the drifted sand of the sea shore, are rendered firm, and of these many have been converted into tillage, and all are perfectly horizontal. Beneath the peat are found sand and sea shells, and these are not the shells of the surrounding seas, but of distant climates. Professor Link picked up in one sandy hill near Schwerin, very little raised above the level of the Baltic, dentalia, murices, trochites perspectivi, and a small nautilus. These could not have been transported by land floods. The ground of this assertion will immediately appear.

The Lake of Schwerin is in the most elevated part of this district, for it discharges its waters at both its extremities, to the North into the Baltic, and to the South by the Elbe, into the ocean. This lake therefore being the uppermost of a succession of lakes, with a descent in both directions, cannot have been excavated by a river, nor yet by land floods and torrents. Nay this lake itself, and those at a lower level, instead of being excavated by water, are daily straitened in their borders by peat and sand, and in process of time must become extensive plains.

It is highly worthy of attention, that round the coast, both of the Baltic and of the North Sea, the enormous granitic blocks appear on the sandy-hills, project from the cliffs, and are scattered on the sea shore, but then it must be particularly noticed, that, when found on the strand, it is always opposite the mouldering cliffs, and not in the outlets of the vales. Had they been transported by mountain torrents, the reverse of this would have been the case, and the blocks would have been most abundant in the channels through which the torrents flow. Hence it is evident, that they must have been originally deposited, where they now appear, imbedded in the sandy-hills, whilst our continents were still covered by the waters of the ocean.

To this observation it must be added, that the cliffs from which they fall, are composed of regular strata, such as must have been formed by subsidence, and not deposited by torrents. In fact wherever, as in the present case, a succession of lakes is to be seen, more especially if they are to any degree deep and extensive, the water issues free from sediment as at Geneva, from whose lake the Rhone comes forth so limpid, that pebbles are distinctly seen at the depth of thirty feet. It is therefore evident, that neither the granitic blocks, above mentioned, nor even the sand was brought here by land floods.

In Tortola granitic blocks of two hundred feet in circumference scattered over an argillaceous surface, have been noticed by Dr. Chisholm. But the detached masses of granite, which have excited most general astonishment, are those well described by Mr. Tooke, in his view of the Russian Empire. These blocks are scattered almost the whole way from St. Petersburg to Novogorod, in the low morasses, and from thence to Valday, which is elevated twelve hundred feet above the level of the

Baltic. From hence the road begins to decline very fast towards Moscow, where the granitic blocks, some rounded, others angular, are numerous, but not so large as on the opposite side of this chain. With them are found lime-stone, chalk, flints, and many blocks of sand-stone, which are rare on the north-west declivity of these mountains.

Saleve and Jura, near Geneva, shew the same kind of blocks. On the latter of these mountains they are deposited more than two thousand seven hundred feet above the surface of the lake. But none are found north of Jura, in Franche Compté, except near Balaigue, opposite to which is an opening to the Alps.

Saussure remarks, that as these rocks have made no pits for themselves, they were not projected by fire, but quietly deposited by water; and he might have said, unattended by volcanic substances. Travelling from Aix to Arles, in the Plain of La Crau, which is twenty square leagues by measurement, he observed one entire expanse of alluvial gravel, fifty feet thick, with pudding stone, bowlder stones, and shingle of calcareous strata, silex, petrosilex, hornstone, porphyry, jasper, and hæmatite, all which he was persuaded had been deposited, neither by the Rhone, nor by the Durance, yet they had clearly been transported from the Alps, and this he conceived to have happened at the retreat of the ocean.

Blocksberg, the highest mountain in the Hartz, is itself grey granite, covered by slate, as that is by lime-stone. But on the most elevated summits of this mountain, and on its numerous branches, granite appears in immense shattered masses, confusedly piled up; " vast ruins of a

" former world." Such was the observation of a learned traveller, who described what he beheld, without any system to support, and without any prejudice to warp his mind.*

It is evident that the granitic blocks, here mentioned, must have travelled from distant abrupt, precipitous, and most elevated peaks, and must have been separated by deep chasms before they began their journey. But such chasms are no where produced by rain, and in the regions of eternal frost no rain can fall.

Nearer home, in Ireland, the County of Wicklow, exhibits vast bowdler limestones, scattered even at considerable heights, on the mountains, and bedded in marl, through extensive districts, where no lime-stone rock is found, nor any rock but granite, horn-stone, and argillaceous schist.†

We have considered the various situations, in which alluvial gravel, bowlder-stones, and granite blocks have been observed.

We may now take a transcient view of some alluvial strata, when united by a cement and become a rock. Such have been long since noticed near St. Albans, in Herts, from whence the most beautiful specimens of silicious PUDDING-STONE have been procured. Similar specimens might have been met with near Croydon, in Surrey, and in the Isle of Wight.

In limestone countries, and in our coal districts, we have frequently occasion to observe silicious, quartzoze, and calcareous breccia. A curious example of such a rock has been particularly noticed, between the Wrekin and Colebrook Dale, consisting of quartz, ochre ball, and other shingle, with a calcareous cement.

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* Baron Born's travels through the Bannat.

† *v.* Irish Reports, Wicklow.

Indeed breccia and pudding-stone seem to be constant attendants on the mountain lime-stone, and frequently alternate with it. Professor Pallas, with his accustomed minuteness, has particularly noticed this in the Crimea. He observes, that on Mount Skala near Tshatyrdag, schist, lime-stone rock, and pudding-stone are frequently repeated.* The same circumstance has been pointed out in a variety of places. With the pudding-stone we may notice the spherical balls of iron ore, which, like the preceding, are attendant on the lime-stone, or, perhaps more properly, attendant on coal. I have some as large as bombs from the Mendip collieries, near Mells, and Professor Pallas has given us a description of something similar at Tarah-tash, near Sudagh, in the Crimea.

On the four mountains in Glamorganshire, near Wormshead, already noticed under the article of pudding-stone, we find large masses of the same rock, with their angles acute, and others equally perfect scattered over the country to a considerable distance. In all these the sharpness of their angles precludes the notion of their having rolled, and their enormous bulk will not allow of their having been dispersed by land floods.

Near Rigiberg, in Switzerland, is a calcareous mountain of pudding-stone, rising more than five thousand eight hundred feet above the level of the sea, at the mouth of a valley of fourteen leagues in length.†

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* Vol. 2, p. 207.

† Saussare § 1943.

Here it is evident, that such mountains cannot have been formed by the common detritus of rain, frost, sun, and wind; nor by any occasional shifting of the river, which waters this extensive valley.

Faujas de S. Fond has indulged us with interesting descriptions, and beautiful engravings, of enormous blocks, pyramids and pillars, in a deep ravine, near Oberstein, which are composed of quartz, pudding-stones, agglutinated by quartz and oxyd of iron, and which merit particular attention.

The most extraordinary mountain of pudding-stone, I ever saw, is Montserrat, composed of shingle and fragments of lime-stone, with a calcareous cement, and yet of such stupendous height, that from its craggy summits are seen the Islands of Majorca and Minorca, at the distance of fifty leagues.

Such dislocations, and such as are reported by Dr. Hutton, from Schreiber, of the gold mine of Gardette, in which the calcareous rock, incumbent on Gneiss, incloses many fragments of granite, can not have been occasioned by land floods, and therefore lead us to seek for some cause more adequate to the effect produced.

Precipitous cliffs and *disrupted mountains*, carry with them unequivocal marks of dislocation. Such are exhibited in the Malvern Hills, which are elevated one thousand four hundred and forty-four feet above the level of the sea. On the Eastern side, a plain extends for many miles; on the Western, a constant succession of hills. Mr. Horner, to whom we are indebted for a most accurate survey of these interesting hills, was fully aware, and particularly noticed, that the stratified rocks, which occur on the Western side, are wanting on the Eastern.

Nothing is more common. Mountains have been rent asunder, and considerable portions, as it has happened to Salisbury Craigs, near Edinburgh, and to a mountain opposite Valence, on the Rhone, have vanished from the sight. Nay, whole districts have been subject to disruption, and have retained no vestige of their abscinded portions. This we have particularly noticed in all the strata which form on the Southern margin of the great basin of the Severn.

Even Continents have been, as it were, bisected, and appear as if one-half of them had been swallowed up in the great abyss. Such a phænomenon fills the mind with wonder, on the Western coast of both North and South America.

But the most striking proof of dislocations may be derived from the MOUNTAIN LIME-STONE, in which the encrinus, and the coral tribes are most abundant. For it is now well understood, that the coral lithophytæ, such as the lime-stone contained, are confined principally to the torrid zone, and never, like the orbicole tribes of sponges, alcyons, flustres, and millipores, deviate from the equator more than thirty-four degrees. Yet their productions are spread over the colder regions of the North, and extend to within a short distance of the Granitic Mountains, which form a boundary against the Frozen Ocean.

OF EXTRANEOUS FOSSILS.

IN all the rock strata, from the chalk downwards, till we approach the granite, we discover extraneous fossils, and till we enter the red ground, we find sea shells in great abundance, not confusedly mixed and blended together, but deposited in families.

These are now to be examined; but prior to this examination, I must take notice of our most ancient alluvial fossils.

Over the chalk districts of our island, but more especially in Essex, like as in Normandy, Picardy, and Champagne, are dispersed numerous species of extraneous fossils, some of which have been noticed by Edward Jacob, Esq. in the appendix to his Botanical Productions of Feversham. These are pyrites, ludus helmontii, selenites, amber, fossil wood, equisetum, fruits, elephant's bones, shark's teeth, tortoise, heads of fish and palates, vertebræ, crabs, prawns and lobster's claws, ovate, galeate, pileate, cordate and placentiform, echinites, Asteriæ, with astroites and asteropodia, belemnites, limpets, orthoceratites, cochleæ, trochi, mytili, cardia, nerites, turbinites, ostreæ, anomiæ, tellinæ, pinnæ, and nautili with their pearly shells.

Walton Cliffs rise to the height of sixteen feet out of an extensive marsh and estuary with a gentle swell, and for the space of about twenty yards, are composed of bluish marl, which contains fragments of chalk, with black flints, and rests on a thin stratum of chalk rubble.

Where this marl terminates it is succeeded by a ridge of clay, extending more than a mile, and dipping North under cliffs of ferruginous sand and gravel. The marl contains numerous teeth. Camden cites Roger de Coggeshall, who wrote at the commencement of the thirteenth century, and related, that in the reign of Richard, prodigious teeth were found at *Edulfiness*, that is Walton in the Ness. These were considered as the teeth of a giant, because two hundred ordinary teeth might be cut out of one them. This venerable historian assures us, that he saw them and handled them himself. Camden was much surprized at this relation, but adds, that another gigantic relique had been discovered near the same place, by the noble Richard Cavendish, in the reign of Queen Elizabeth. He however was himself of opinion, that the teeth in question must have been left by elephants, and probably by those which had been brought into Britain by the Romans.

Within the last thirty years, the under jaw, numerous teeth, many tusks, and some bones of Asiatic elephants, have been collected by my friend Dr. Menish, with the tusks of the hippopotamus, one of which measured nearly twenty inches in length, and ten inches in circumference, although not entire. Other kinds of teeth were found with these, and many horns of some species, both of the ox, and the elk, with which we are not acquainted.

All these appear in the marl, and are confined within one yard of the chalk stratum already noticed, on which the marl reposes. In the clay we find other bones, not, like the former, in a state of decay, but petrified, solid and remarkable sonorous.

The Northern portion of these cliffs, at a higher level, contains the bed of shells noticed by Dale, in his Antiquities of Harwich, which appears in Suffolk, about seven feet below the surface, calcined, and used for manure. This bed has silicious sand tinctured brown with iron.

It is remarkable, that although among these shells we find many of the same genera and species as have been noticed by Brander, in his Hampshire fossils, and by Lamarck, in his account of the fossil shells of the vicinity of Paris; yet with these are to be observed numerous shells of the circumjacent seas, such as the pholas, various murices, the Buxinum lapillus, and, according to De Luc, Cardium edule, Venus rotundata, and Turbo terebra.

FOSSILS OF WALTON, IN ESSEX,

AS CLASSED BY DR. MENISH.

I. MULTIVALVES

1 Lepas Balanoides, adhering to other shells
2 Pholas Candidus
3 Pholas Crispata
4 Pholas Dactylus

II. Bivalves

5 Pecten Subrufus
6 Pecten inæquiauritus, radiis 26, cum aliis parvis linearibus
7 Cardium muricatum
8 Cardium fasciatum
9 Cardium imbricatum
10 Mactra glauca
11 Ostrea oblongata, Brander f. 83
12 Ostrea distorta, new
13 Ostrea auricularia
14 Venus exoleta
15 Venus gallina. Brander f. 94
16 Venus striatula
17 Chama antiquata
18 Tellina fabula, Donovan B. S. vol. 3, p. 97
19 Tellina variegata, Lister f. 384. f. 227
20 Donax Plebeia, Montague, p. 5, f. 2
21 Donax trigona
22 Arca glycymeris

23 Arca nucleus
24 Anomia magalope, new
25 Mytilus curvus, Lister, t. 363, No. 204
26 Solen siliqua
27 Solen ensis
II. Univalves
28 Patella ungarica
29 Patella fissura
30 Patella albida
31 Patella mamillaris, Lamark Cornucopiæ
32 Patella militaris, Montague, p. 488
33 Trochus granulatus
34 Cypræa pediculus
35 Voluta glabrata
36 Buccinum undatum
37 Buccinum reticulatum
38 Buccinum lapillus
39 Buccinum confragosum
40 Murex turbinatus
41 Turbo littoreus
42 Turbo duplicatus
43 Helix mutabilis, Brander 32
44 Nerita canrena
45 Nerita nitida, Donovan
46 Murex corneus
47 Murex carinatus, Donovan pl. 109
48 Murex despectus
49 Murex despectus contrarius
50 Murex undosus
51 Murex cancellatus
52 Murex plicatus, Faujas de S. Fond, pl. 1, f. 6
53 Voluta ampullacea
54 Cellaria reptans, Ellis
IV. Spongia officinalis.

Of these fossils the Doctor permitted me to make drawings.

On the estate of Claud Scott, Esq. at Bromley, in Kent, a ridge of high hills contains a bed of silicious shingle, with sea sand and oyster shells, many of which appear upon the surface, and are turned up by the plough. These are attached to the shingle, or rounded gravel, in such a manner, and are so perfect, as clearly to demonstrate that no attrition has taken place since the oyster embraced the stone.

It is to Mr. Parkinson that we are indebted for the record of a most inestimable fact, which throws light on the subject immediately before us. By this record it appears, that the same bed which carries the above-mentioned fossils, has been discovered by cutting through Highgate Hill, as well as at Kew. And he very judiciously distinguishes the various dates of the fossil shells, which appear in the gravel beds, in this clay stratum, and in the most ancient strata of more elevated regions.*

In this branch of the science Dr. Menish took the lead. In his arrangement he considered fossil shells as referring to different epochs, and accordingly distinguished them into—

1. Primeval; 2. Ancient alluvial, which may be called Diluvian; 3. Recent alluvial.

The propriety of these distinctions will immediately appear.

1. The primeval shells possess characters peculiar to themselves. They are petrified and commonly partake of the same nature with the beds in which they were inclosed. They are frequently casts; and in porous rocks, we discover merely their impression. In most instances, the shell itself has vanished, and the vacuity it left either still remains, or is partly occupied by calcareous spar, by pyrites, by silex, or by iron ore, or is completely filled by some one of these substances.

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* v. Transactions of the Geological Society, vol. I. page 338.

Another character peculiar to this class, is their being distributed by families, and confined in a great measure each to its own stratum, with their position in their proper beds, the same as if they were now lying undisturbed at the bottom of the ocean. Comparatively few of these are found recent.

2. The ancient alluvial shells are in extensive beds of sand, marl, and clay. The instances are rare in which they are found petrified, or much connected with the bed inclosing them. Very few shells of this class are of the genera, or species of the shells of the first class; but the genera and species are peculiar to themselves. Most of them are at present unknown as living shells; and such as are known to us in a recent state, are chiefly the inhabitants of other climates. The different species are not like those of the first class, deposited by families in distinct beds, but the various species are thrown together in promiscuous heaps, as in Essex, Hampshire, and in the vicinity of Paris. Two hundred species of these last are classed and well described by Lamarck, in the Annals of the Museum.

Albert Fortis has made mention of similar beds of clay in the Vicentin, which contain the same species of shells as have been noticed in Hordwell cliff by Brander, and accurately described by Dr. Solander. Among these we find his turbo terebra, helix mutabilis, murex minax, with other species of turbines and murices, many bivalves, and numerous madreporæ, not petrified, but half calcined.*

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* Albert Fortis Oryctographie, de l'Italie, tom. I. p. 146.

I have similar specimens from Woolwich, from Hordwell cliffs, in Hants; from Walton and Harwich cliffs, in Essex; from Touraine, in France; and from Mount Saleve, in Switzerland. From the marly clay of the Essex coast, I have received many perfect shells of warm climates, with their pearly coat unchanged, yet extremely tender. Among these, the large chambered nautili of South End deserve particular attention, because they are in the alluvial strata, yet were never transported by mountain torrents, for such is their brittleness and bulk, that had they been subject to triture, they must have been broken to pieces, or even ground to powder. They were deposited therefore in deep water. Similar nautili have been observed in the island of Sheppy; at Richmond, in Surrey; and at Sherbourne, in Dorsetshire.*

But that which, in Essex, demands more particular attention, is the quantity of fossil wood variously changed, after having been penetrated by the Teredo navalis. Of this my friend, Dr. Menish, has indulged me with numerous specimens, collected by himself at Walton. These appear to have had four distinct states of existence. 1. As the living vegetable; 2. As exposed in the sea to the Teredo; 3. As inclosed in various rocks, of whose nature they partake; 4. As fractured and dispersed with portions of those rocks, in the form of septaria, and deposited in the enormous bed of clay, which constitutes the cliffs and Southern districts of the county.

No less remarkable are the spoils of elephants, here found in vast abundance. In one day's excursion with Dr. Menish, we added to our collections two tusks and three teeth, the ivory of which is in the highest state of preservation. One tusk, in a state of calcination, measured nearly seven feet. Among these spoils of the elephant we observed a triquetral tusk, supposed to be of the hippopotamus, near twenty inches in length, of which I took a drawing on the spot.

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* *v.* De Luc and Whitehurst.

The difference between primeval, and ancient alluvial, or diluvian shells, is remarkable, and highly worthy of our notice.

The former seem to have been quietly deposited in orderly succession. They appear, as I have stated, in families, and lie as if they were in the bed of the ocean, where for ages they were collected and subject to decay. Their substance has been carried off, and the vacuities have been occupied by heterogeneous matters, apparently introduced by filtration.

The latter seem to have been transported from distant climates, and to have been deposited in a tumultuous manner by some grand convulsion, which blended and buried terrene and sub-marine productions, ancient and recent, in one common grave.

The direction in which they have been conveyed, appears to have been from S. E. to N. W. Hence, where we have an opportunity of making distinctions respecting their natural habitat, as in the Asiatic and African elephants, it is remarkable that the former, and not the latter, are to be found fossil in the North of Europe.

Should the latter have been transported from their native seats by the same convulsion, it is probable that their reliques have been deposited in the Atlantic Ocean.

This observation might have been reserved for the Chapter on Geological Conjectures, but it has occurred to my recollection, and even here it may appear not to have been misplaced. I am happy to find that M. M. Cuvier and Brongniart agree with me in the opinion I have here delivered; for in the Annales du Museum 4^{me} Cahier, p. 294, they consider these remains as exhibiting a decided character of a vast irruption from the S. E. forming capes and vallies, and placing before our eyes the last revolutions, which have terminated the formation of our continents.

3. The recent alluvial shells are found either superficial, or at considerable depths under clay and sand, and are of the same species with those of the neighbouring coasts. Such shells have been particularly noticed by Professor Pallas, in the country bordering on the Euxine and the Caspian, between the Volga and the Don.

In Cornwall, on the margin of the sea, shells of this class are found at considerable depths under morasses, and correspond in species to those of the coast; but marine productions of the two former classes are unknown. Shells of this class abound on the coast of the Carnatic, extending as far in land as Vellore, fifty miles from the sea, which being dug up, are exposed to the weather, and afterwards calcined, to make the plaister called chunam.

The hills in Kent exhibit the same fossils nearly as those of Essex. Dr. Menish, in a visit to his friend Claud Scott, Esq. in the parish of Bromley, picked up from a bed of sand, intermixed with shingle of the silicious kind, some *turbinated shells* and tellinites, of which he gives me the subsequent description.

The turbinated shells and tellinites are found in beds of sand, which dip in an angle of 45° to the East. With these are numerous oyster shells, many of which are discovered closely adhering to the smooth and rounded gravel, on which they had fixed themselves. The living shells, at the time of the retreat of the waters, still retain their valves connected; but there are many single shells, which are worm-eaten, or covered by serpulæ, with all the appearance of having been dead shells at the time.

On the opposite hill is a small stratum of shells, consisting of tellines and turbines, with a few small oyster shells. These are in so decayed a state, that they prove an excellent manure, and are used for that purpose. This last bed is found at a little depth under the surface, but varying in different places in this respect, as it extends in patches over this part of the country. The oyster shells, on the contrary, appear, together with the sand and shingle, to compose the body of the hill, where they are found, and which is situated about nine miles from the Thames, and sixty from the sea, above the level of which it is considerably elevated.

This great bed of clay carries a rock stratum, charged with turbinated shells and tellinites, which, near Paris and the Bois de Boulogne, supplies building stone. I have never traced a vestige of this rock in our strata, not even in Kent or Essex; but a friend, on whose judgment I can depend, assures me he has seen it near Carisbrook Castle, in the Isle of Wight, on the bed of clay which is incumbent on the chalk, and from report, I am inclined to think that the same bed is extended to the East of Cowes.

Having thus examined our alluvial shells, I shall now proceed with the extraneous fossils of those rock strata which I have enumerated, beginning with the chalk.

I. CHALK FOSSILS.

In the chalk beds of Picardy, Normandy, and Champaign, M. M. Cuvier and Brongniart collected fifty species of fossil shells, which are peculiar to these beds. Our Wiltshire chalk has comparatively few fossils, and these are chiefly echinites, terebratulites, and two species of anomites. But in various districts other shells appear, such as cardites, pectinites, chamites, trochites, buccinites, madreporites, belemnites, and dentalia, with some oval ammonites. In Essex, Dr. Menish has collected from the chalk, anomia terebratula, anomia lacunosa, ostrea diluviana, six species of pecten, two of belemnites, eight of echinites, two of madreporites, and two of tubiporites, with some beautiful palates. Mr. Parkinson, of Hoxton, has a pecten armed with very slender spines, of one inch and a half in length, which circumstance is highly worthy our attention.

The most remarkable contents of chalk are the beds and detached nodules of flint. In some extensive gravel pits, the flint beds appear like metallic veins, and frequently discover vacuities in the middle, between the walls. Over and beneath the chalk stratum, many detached nodules contain zoophytes, particularly the alcyonium, the sponge, and the cup coral. Indeed I have not seen one nodule of flint in Wiltshire without vestiges of their existence, and many contain them either entire or in fragments. In some, the zoophyte has vanished, and has left a vacuity which has been subsequently occupied by flint, agate, or calcedony, many specimens of which exhibit beautiful mammillæ; but these are chiefly found at the bottom of the chalk, incumbent on the green sand of Pewsey vale.

As far as my observations go, zoophytes appear universally to have formed the nuclei of nodulated and coated flints.

Of the echinites, which commonly are calcareous spar, even when inclosed in flint, many are filled with chalk, some are equally divided between flint and chalk, and others are not merely occupied by flint, but seem to overflow, as if a superabundant quantity had, in a state of fusion, been poured into them.

We are greatly indebted to Mr. Parkinson for the most correct figures of extraneous fossils, that ever were presented to the public.

In his second volume he has given us two beautiful turbinated madreporites, found in chalk, plate IV. fig. 15, 16; a remose alcyonite plate VII. fig. 6; and a chalk alcyonite, pl. X. fig. 12.

In the same volume, the plates IX. and X. exhibit the most interesting sections of alcyonites, which are perfectly new to us.

In the four first plates of his third volume, we have the echinites most of which are to be found in Wiltshire, either in the chalk, or recumbent on the green sand beneath the chalk.

The ninth plate of this volume contains the oval ammonite, in chalk, which, till of late, was regarded as distorted. Near Warminster these are most abundant.

II. SAND FOSSILS.

A. GREEN SAND FOSSILS.

The green sand immediately under the chalk, in Wiltshire, contains many porpital madreporites, serpulites, echinites, ammonites, nautilites, helicites, trochites, chama gryphoides, and the anomia caput serpentis, in the highest perfection.

It contains also many large sand-stone casts of nautilites, some of which measure three feet in circumference, and a few shells, which seem to be perfectly unchanged, but very brittle, and exceedingly minute, such as serpulæ, nautili, trochi, turbines, lobster claws and glassopetræ. These are dispersed chiefly among the alluvial sand, gravel, and vast bowlder stones. Consequently such light and delicately tender shells cannot have been transported and deposited by land floods, but must have subsided in deep water. Some of the shells are in a state of decay, appearing like tender brittle chalk.

Many of the casts are agatized. These are in two several states; for the silicious matter either has occupied the whole space deserted by the shell, or is merely superficial being to appearance a perfect model of the shell, but discovering internally, when broken, a vacuity. And it is particularly worthy of attention, that in some pectinites, the most minute processes resembling spines, discover the same vacuities. The impressions are sharp, and shew clearly that, since they were formed, they have never rolled so as to have been subject to attrition. These must, therefore, have been originally deposited in deep water, and since that time cannot have been removed by land floods.

Many shells have disappeared, more especially echinites, and have left perfect vacuities, unoccupied either by silicious or by calcareous matter. In other specimens the impression of the external surface of the shell remains inclosing a loose sand-stone nucleus, resembling the echinite, in which it was formed. With these fossils, in the green sand, we find perfect crystals of quartz.

In a silicious gravel-pit, opened in green sand, immediately under the chalk hills, in the most elevated region of the West of England, I found a solitary specimen of cup coral in high preservation, with its organic structure perfectly discernible, not silicious, but calcareous and susceptible of high polish. It perfectly resembles both in substance and in shape the cup coral of the bastard free-stone, in the vicinity of Bath, and has not the least resemblance to chalk fossils, which are either chalk or flint, nor yet to the sand fossils, which are silicious and mostly agatized. This therefore must have been derived from one of the inferior strata, and cannot have been dislocated by rain, wind, and frost, nor deposited by land floods.

The bed of sand contains numerous sponges and cup corals, agatized and inclosed in a thick coat of green sand-stone, of which they form the nucleus. The covering of each cup is rounded like a skull, and, till broken, perfectly conceals the cup. The stem is equally concealed, except at the termination, which is universally abrupt, smooth in its surface, and, like the inclosing sand-stone, sharp in its edge, so as to prove, that neither any fresh increase by corpuscular attraction, nor diminution by attrition and abrasion, has taken place since it was separated from its base. Yet these are here deposited with shingle in the alluvial stratum. Such phœnomena demonstrate, that this assemblage was not made by land floods, that the rotundity of the nodules was not occasioned on the sea shore by the flux and reflux of the tide.

Mr. Parkinson's ramose alcyonite, from Berkshire, exhibited in his second volume, plate VII. fig. 12. is probably from the green sand, possibly from the grey sand. Many such are to be seen round Pewsey.

His first plate of vol. III. has from this bed two echinites, n. 12. and n. 13.

The alcyonium, in the frontispiece of his second volume, is abundant in the green sand of Pewsey Vale. I conceive it to be either a cup coral or a sponge.

B. GREY SAND FOSSILS.

The grey sand, in Wiltshire, contains ammonites, mytilites, the turbo terebra, one species of the venus shell, and the casts of branchy corals. At Swindon, in a quarry opened for flag-stones and for lime-stone, we find remarkable beds, separated by white silicious sand, containing ammonites and the venus shell in great abundance, oysters, cockles, horsehead muscles, beautiful studded cunei and turbinated shells, as at Fonthill and Portland. In one block of sand-stone, Mr. Richardson found numerous stems of corals, as in the vale of Pewsey and at Pottern. These I have ventured to consider as corresponding beds.

In the pits of Blackdown, in Devonshire, we have a rich assemblage of agatized shells. These appear to be in a stratum nearly connected with the grey sand stone of Swindon, which is there evidently far beneath the chalk. In the cabinet of Dr. Menish, at Chelmsford, I took notice of the subsequent, named by him, all found in the grey silicious sand bed, from which are obtained whet-stones and grind-stones, consisting principally of quartz and mica, with a silicious cement.

1 Chama lævigata
2 Arca lævigata
3 Arca subaurita
4 Arca noæ
5 Arca nucleus
6 Arca exigua
7 Arca subrostrata
8 Venus islandica
9 Venus gibbosa
10 Venus gallina
11 Venus trigonella
12 Venus exoleta
13 Venus lævigata
14 Tellina triquetra
15 Tellina rugosa
16 Cardium muricatum Listeri appendice ad librum iii. No. 28.
17 Cardium calcedo
18 Cardium striatum vel discors
19 Pecten rugosus, a singular shell
20 Pecten cardiformis
21 Buccinum buccino spirato affine
22 Buccinum striatum
23 Strombus Hamus. Rostellarite of Parkinson
24 Strombus monodactylus, ditto
25 Nerita canrena
26 Murex colcar
27 Turbo terebra
28 Turbo crenatus
29 Dentalium Entalis
30 Ostrea Arborea
31 Ostrea recurvirostra
32 Mytilus oblique auritus
33 Cuneus echinatus
34 Cuneus porcatus
35 Cuneus myoides
36 Cornu ammonis complanatum
37 Cornu ammonis lævigatum
38 Cornu ammonis undatum
39 Echinus spatagus

40 Serpula turbinata siliquaria of Lamarck
41 Isis—nobilis
42 Zoophytum squamosum
43 Madrepora fungites
44 Alcyonium pyriforme
45 Pholas maxima
46 Pinna margaritacea, with its pearly colour still remaining. It is in the cabinet of Mr. Hanson
47 Mytilus ptereoideus
48 Corallium reteporum.

Some of these are well figured by Mr. Parkinson, in his third volume, plates 5. 6. and 12.

C. THE RED SAND FOSSILS.

In this bed we find most of the chalk fossils washed down and imbedded in its upper surface, particularly various species of coral and anomites, with echinites and their spines, most of which are tinged red by the carbonate of iron.

III. THE SUPERIOR OOLITE FOSSILS.

This rock is chiefly distinguished by the echinus spatagus, and numerous mammellated echinites, some few full grown, but in general exceedingly minute. The sand attending this rock contains nerites, strombites, pectinites, and oyster shells, which likewise abound in its subjacent marl. These last, at Shotover, appear in substance either perfect and unchanged, or else eroded by sulphuric acid, and covered with selinite, whose crystals occupy, in some instances the external, in others the internal surface of the shells. But in many, both parts of the Shell have suffered equal loss, and have made the same acquisition of pellucid crystals.

—Some of the perfect shells shew barnicles and the perforations of the pholas.

In Plott's Oxfordshire, we have beautiful engravings of these fossils, particularly such as he picked up at Heddington. And in Morton's Northamptonshire, table 10, fig. 2, 3, 4, 5, 8, 10, we find engravings equally well executed of echinites, collected near Helmdon, Workton, and Desborow.

IV. THE CALCAREOUS GRIT FOSSILS.

In the sand of this bed we find ammonites, many beaked oyster shells, some large oysters, whose species I have not ascertained, and numerous ochre balls. In the clay and black marl are ammonites with their pearly shells entire, which retain their iridescent colours.

V. THE CORAL RAG FOSSILS

This highly interesting stratum is composed chiefly of corals, with their spoils, and contains coxcomb, oysters, the *mytilus crista galli* of Linnæus, mammellated echinites, with their spines in the most perfect state of preservation, casts of the cuneus, pectinites, buccinites, one species of venus shell, the pholas, and numerous mytilites. Among these we find mytili, with their cables, frequently inclosed in a smooth covering of calcareous paste, of which they form the nucleus. Well executed drawings of these we find in Plott's Oxfordshire, plate 2, No. 4, 6, 7, 9, 10.—plate 4, fig. 1, 2, 5, 6, 10, 11, 12, 13, 14, 15, 17, 18, 19.—

plate 5, fig. 1, 2, 5, 6, 8, 9, 10, 14.—plate 6, fig. 2, 8, 9, 11, 12, 13.—plate 7, and in Morton's Northamptonshire, table 3, fig. 1, 9,—table 4, fig. 2, 3, 4, 5.—table 5, fig. 1, 2, 3.—table 6, fig. 89,—table 7, fig. 13, 26. Mr. Parkinson has enriched his work with several fossils from this bed, as may be seen in Vol. II. plate 5, fig. 5.—plate 6, fig. 4.—plate 7, fig. 11. Vol. III. plate 15, fig. 2, 4.—plate 12, fig. 3.

A very indifferent figure of the coated mytilus may be found in Ed. Luid.* which he conceives to be a pholas. His figure of the studded cuneus, by him called curvirostra rugosa clavellata, is excellent.

The vast bed of clay, which intervenes between this rock and the Kelloway rock, has large bowlder-stones composed principally of ammonites with their pearly shells unchanged, and so perfect as to retain their iridescent colours. These were found principally at Marston Magna. But other species of ammonites, equally iridescent, were formerly collected from a deep pit at Melksham.

VI. THE KELLOWAY ROCK FOSSILS.

This rock abounds with nautilites of various kinds, and several species of ammonites with mytilites, anomites, and tellinites.

It is distinguished by its lobate oyster, and more especially by its vast variety of ammonites. See Morton's Northamptonshire, table 3, fig. 9.—table 5, fig. 5, 14, 15, 16.—table 6, fig. 22.—table 8, fig. 1, 10.—table 9, fig. 1, 11.

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* Table 10, numbers, 877 and 878.

VII. THE CORN BRASH FOSSILS.

In this bed we find several varieties of the anomia terebratula, some small and round, others of an uncommon size; mytili of different species, the echinus spatagus and other echinites, cardia, a peculiar species of beaked oyster, very small and curved, numerous fragments of the vertebral column of pentacrinites, with some pectinites, tellinites, trochites, ammonites, and nautilites. A studded cuneus was found at Chatley, in the same stratum. A similar one is noticed and figured by Morton in his Northamptonshire, table 6, fig. 9, 20. The best fossils will probably be found near to Malmesbury, where the rock, being fourteen feet thick and solid, is much quarried for building stone.

The blue clay under the corn brash is chiefly distinguished by its cone coralloide.

VIII. THE FOREST MARBLE FOSSILS.

Fragments of bivalves with a few ammonites and cardites constitute the principal part of the forest marble. It contains bufonites, palates,* and dentalia with spines of echinites, but is chiefly characterized by bits of coal which are evidently fossil-wood.

This rock is hard, compact and susceptible of high polish, and, when polished, shews innumerable fragments of shells, the originals of which I have never been able to discover.

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* Siliquastra.

IX. THE GREAT OOLITE FOSSILS.

In the body of the rock I have seldom found a perfect shell: but on the surface of the uppermost bed it has a rich assemblage of extraneous fossils imbedded in white clay, as may be observed at Winsley, and on the ploughed lands all the way from thence as we descend to Bradford. Under the clay numerous shells appear agglutinated to the rock. These are perfectly unbroken, but under them are large fragments, and beneath these lesser fragments successively, till they terminate in a granulated stone, called oolite or free-stone.

Among the extraneous fossils, imbedded in the white clay, the most interesting are the encrinites, first noticed by the Rev. Benjamin Richardson, at Burfield, near the summit of the hill, on the Southern hanging of which Bradford stands. They were next discovered South of the river, on the surface of the rock, in the same bed of white clay, but more than one hundred and fifty feet lower than Burfield, and a little elevated above the level of the river. Finally they were traced on the high summit of the opposite hill, yet always deposited in their proper bed.

Mr. Parkinson has denominated this species the *pear encrinite*, because of its form and apt resemblance to a pear in that part of the animal, which has been usually called *stone lily*.

He very properly remarks, that round Bradford this portion of the animal, attended by its pedicle, is abundant, whilst fragments of the vertebral column are comparatively scarce. And as to the arms, fingers, and claspers, although both myself and many of my friends have sought for them with the most diligent and minute attention, we have never been so fortunate as to meet with even the least fragments of them.

The figures given by Mr. Parkinson of this extraordinary fossil, in the sixteenth plate of his second volume, are exact representations of the specimens, with which I was able to supply him.

To his description I have little to add. He has particularly noticed an aperture, which, as it is supposed, leads to the stomach. Since the time of his publication I have met with numerous instances of something resembling an operculum, by which this aperture is closed. Many of my friends possess specimens of the pear encrinite with these opercula, if such they may be called.

From the observations of Mr. Parkinson, it is sufficiently clear, that the purple fragments which attend these stone lilies, must be considered as their pedicles. The innumerable instances I have met with of these fragments adhering to the rock, and containing trochitæ of precisely the same size, form, and substance with those of the encrinus, leave no room to doubt of their being allied to each other. In proportion as the animal increased in size, the pedicle was extended in circumference, so as to secure a firm support. I have polished one specimen, which exhibits its annual increase, somewhat like that from Soissons, which appears in fig. 13 of plate 16, of Mr. Parkinson's second volume. By some of the specimens in my possession it appears, that when a vertebral column has been broken, the abandoned pedicle has been taken as the base of a new superstructure, after which its dimensions have been extended.

The longest vertebral column I possess measures two inches and a half, and is composed of fifty-nine trochitæ.

Mr. Parkinson's figures, numbers 1 and 5, of his sixteenth plate, beautifully exhibit the concentric circles and radiated appearance of the vertebræ, with the perforation for the spinal marrow.

Innumerable detached fragments of the stone-lily are found dispersed in the white clay, and many are agglutinated to the surface of the rock. Of these some have been occupied by a particular species of tubipore, whilst the pedicles themselves appear to have escaped this invasion. I have before me a fragment consisting of four vertebræ, which contains fourteen colonies. Their cities are circular. Of these the most extensive measure a quarter of an inch in diameter, and the least about one-twentieth of an inch: yet even the smallest of these contains twelve habitations. These fragments must have existed as such in the bosom of the ocean, because every part of the fragment external and internal, has been equally invaded, and this must have happened in deep water, for the edges both of the fragment and of the habitations, discover not the least abrasion.

With the physiology and habits of these animals we are wholly unacquainted. From Mr. Cumberland, of Bristol, we may expect a more perfect description than we now possess.

As for the pentacrinite, I never met with it at Bradford.

On the surface of the rock we have tubiporites, and numerous madreporites. Of this some affect the cup-like form, but the tubiporites are principally branchy. Among these corallites are interspersed, several species of anomites, more especially the anomia striata reticulata, and the anomia saccus, or terebratula triquetra of Parkinson, which, with the pear encrinus, are characteristic of this rock.

We have likewise several species of oyster, which are almost peculiar to this rock. With them are found serpulites, echinites, bufonites, belemnites, porpitæ, siliquastra, pectinites, and a beautiful mytilus costatus.

The uppermost stratum of this rock, like the forest marble, has bits of charcoal imbedded in it.

In Mr. Parkinson's organic remains, vol. 2, plate 16, we have ten figures of the encrinite fragments, which do much credit to his engraver. These were collected in the white clay, on the back of this rock at Bradford. Dr. Morton's Northamptonshire, in table 3, fig. 1, 5, contains some of the bivalves of the white clay bed.

Beneath this rock, in the great bed composed of clay and fullers' earth, may be collected seven species of anomia, some mytilites, and both the pecten monotis and the hog's ear oyster, *ostrea diluviana* Lin. in the highest state of preservation. This last is well represented by Parkinson, vol. 3, pl. 15, fig. 1.

X. THE INFERIOR OOLITE FOSSILS.

This porous rock abounds with typolites, or casts of marine shells, which have vanished, and left vacuities unoccupied by calcareous spar. It has likewise numerous fossil-shells, by some of which it may be distinguished from all other rock strata.

The first of these, at least as far as my observations extend, is a large oyster, of a transverse fibrous texture, consequently extremely brittle, and seldom found entire. Its fragments exhibit a striated calcareous substance, brown and resembling asbestus.

The Rev. Peter Hawker, Rector of Woodchester, in Gloucestershire, has one valve perfect, measuring nearly nine inches by seven, and in form somewhat resembling a shoulder of mutton. I have a fragment, part of which is five-eights of an inch in thickness, and on its surface retains a portion of the shell unchanged. I have seen it described as *ostrea trichites*, and Saussure, who has given us a figure, calls it *pinnigene.*

This rock is likewise distinguished by its shingle of white quartz, and by the anomia spinosa Linnæi, or the anomia ventricosa striata echinata of Knorr, who has left us an excellent figure of this shell in the fourth book of the second part of his valuable work.

This rock abounds with cunei, which, not having been classed by Linnæus, my valuable friend, Dr. Menish, was at one time disposed to call theraulaxiæ, but ultimately he denominated this shell venus trigonella. Mr. Parkinson, with great propriety, adopts from Bruguiere, the term trigonia. Of this genus we have in our rock two species, distinguished by him as trigonia clavellata, and trigonia costata, of which the most beautiful specimens are in the cabinet of Mr. John Hawker, at Dudbridge, in Gloucestershire.

Wherever it occurs, this rock may be identified by the bottom bed, charged abundantly with ribbed and studded cunei, and with their casts, called hippocephaloides, immediately over which is a coral bed, which is compact, extremely hard, and susceptible of high polish.

The coral bed contains the madrepora cinerascens, which is found recent in the Indian seas. One of these curious petrifactions was standing upright more than five feet high, and expanding nearly six feet, with a double cup, much fractured, but no fragment is scattered to a distance. It was, A. D. 1802, examined by several gentlemen.

The remains are to be seen near Midford, in the lane leading from thence to South Stoke. In its cavities it contains numerous coated mytili, with their cables covered by a crust, on some of which corals have begun to build.

I have before me the hollow valve of a pectinite, to which many coated mytili have attached themselves, each by its cable, and many fragments of the cables remain without their mytili. These were conceived to be *fistulanas* by Dr. Menish, to whom I sent several specimens, and particularly No. 7, of plate 14, vol. 3, of Mr. Parkinson. But I can discern no resemblance between them and the fistulanas of Lamarck, as represented in plate 24, fig. 6, 9, of the Annales du Museum, of which that celebrated concologist, for a long time considered the sheath as the real shell. The fistulana of Lamarck is an æquivalve included in a club-formed testaceous tube. It sometimes passes out of its own proper shelly tube and takes refuge in tubular cavities, formed in stone and other solid bodies.

Faujas Saint Fond has given a description, attended by figures of his fistulana lagenula, which he considers as the *Solen arenarius* of Rumphius; but the figure does not resemble any of the fistulanas of Lamarck. It approaches much nearer to our coated mytilus, and such, I am inclined to think, it may have been.

The fistulana, according to St. Fond, should be "covered with "fragments of shells, wood, stone, or other bodies." The covering of our coated mytilus is perfectly smooth, unless when the coral polypous builds his habitation on it.

We have the pholas dactylus, the mytilus modiolus, and the mytilus lithophagus; but I have never seen the fistulanas in our rocks round Bath.

It appears to be a law of nature, that thin-shelled animals, such as here enumerated, should take refuge in cavities, commonly, but not always formed by themselves, in rocks, in corals, and in the thick shells of other fish. Such of them as are unable to find refuge in foreign bodies, are, like the paper nautilus, inhabitants of the deep.

The *fistulana*, as we have seen, is able to pass out of its shelly tube. This power was never possessed by our coated mytili, for universally the mytilus is much larger than the byssus, by which it is attached to stable bodies. Edward Luid was acquainted with our coated mytilus: but he called it pholas amygdaloides fasciata, seu scabro quodam involucro plerumque obducta, a description which is not perfectly exact. See his No. 877, 878.

Over the two beds of this rock, which contain the corals and the cunei, with their hyppocephaloide casts, in the superior bed we have found, besides the ostrea trichites and the echinated anomia, nautilites, ammonites, volutes, trochites, turbinites, helix cochlea, helix decollata, arca noæ, madrepora porpita, a variety of the patella ungarica and beautiful specimens of the ostrea diluviana.

The sand bed immediately under this rock, contains, on its surface, numerous and perfect specimens of the ostrea gibba, ostrea plica, ostrea edulis, one species of venus, whose valves measure seven inches by six, and the two united are five inches diameter; another species of venus is of much larger dimensions, but not so thick.

This bed contains casts of the mya, of mytili, and of some donax, with agglutinated masses of yellow ochre, called sand burrs, all rounded at the edges.

On the surface of the blue marl, immediately beneath the sand bed, is a thin rock, called Yeovil marble, containing ammonites and belemnites, tinctured by carbonate of iron; and a few feet below this we find a brown bed, very hard, compact, and composed of flatted shells of the ostrea gibba, commonly called pectens.

XI. THE LYAS FOSSILS.

The lyas beds are exceedingly abundant in extraneous fossils. Among these we find the ostrea gryphus, and other species of oyster. These, with ammonites, and venus shells of enormous size, are characteristic of the lyas beds. With them we find turbinites, trochites, terebratulites, modiolites, and chamites, siliquastra and asteriæ.

But the extraneous fossils, which are most characteristic of these beds, are vertebræ and jaws, some in the rock itself, and others in the intermediate beds of clay.

One jaw, in the possession of Jacob Wilkinson, Esq. near Bath, is regularly studded on each side with bufonites. Among his fossils another jaw, belonging, it is supposed, to the aligator, has all its teeth, both upper and under. These are apparently unchanged.

But the most remarkable fossil, I ever saw, is a supposed aligator, in the cabinet of the Rev. Peter Hawker, which with indefatigable industry and hard labour, he brought to light, from a lyas quarry, near Bath. The head is three feet long, and from the eye to the extremity of the jaw is two feet nine inches. It is furnished with one hundred and twenty teeth, which are an inch and a half long, sharp pointed, and well preserved. At different times he procured from the workmen fifty joints of the spine, measuring together six feet, and six joints of the tail, with many vertebræ, and some other bones not well defined. Pilkington mentions one aligator found in black marble, at Ashford, in Derbyshire.

The jaws which abound at Charmouth, are similar to these.

Other jaws discovered in the lyas quarries, near Bath, have numerous teeth, which are adunque.

The siliquastra are frequently arranged, as in the palate of a fish. At Bitton one specimen was found containing sixteen siliquastra, placed side by side, in three tier, diminishing in size. The first row has seven large ones, the second has six lesser, and the third has three much less than the former. Lord Donegal obtained a specimen from the neighbourhood of Bath, in which the arrangement was similar to this, with an equal number of the siliquastra on its reverse, so as to resemble a tongue. Sir Ashton Lever was possessed of one specimen containing twenty. In all these we discover marks of attrition, as if occasioned by grinding food.

I have a drawing of one perfect fish, measuring ten inches by four, with its scales resplendent and of a rich brown colour, as well preserved as in its recent state. It is the property of Mr, Trotman, In the bottom bed of the lyas, contiguous to the red ground, is a most extraordinary assemblage of fish palates and shark's teeth, forming a distinct bed, deposited in black marl. The most beautiful specimens of these are from Westbury cliffs, on the borders of the Severn.

The asteriæ, or fragments of the vertebral column of the pentacrinite, are extremely numerous; so likewise are the claspers of this wonderful animal, but I have never been so fortunate as to find either its head or pedicle in lyas.

In the cabinet of Mr. Harford, at Stapleton, near Bristol, is a wonderful remnant of a briaræan pentacrinite, from Keynsham, with its numerous arms or branches, which, if properly extended, would, I am persuaded, occupy a space of many hundred cubic feet. This therefore must have existed in deep water, or certainly in such a situation as not to be deserted by the tides.

In the Philosophical Transactions Mr. Ellis gave a figure of the Barbadoes pentacrinite, which he describes as *encrinus* capite stellato, ramoso dichotomo, stipite pentagono equisetiformi. The encrinus, in my opinion, is not erratic, but fixed by its asteropodium, or pedicle, to some stable body, and I am inclined to think the same of the pentacrinite. Many fossils of this bed are described by Parkinson, in the second volume of his inestimable work, and may be seen plate XVII, fig. 9, 16—pl. XVIII. figures 1, 2, 3 Knorr, p. II. b. I. e. has excellent drawings of the venus shell.

The watchet *lyas*, as I apprehend, has neither the pentacrinite nor the jaws and vertebræ of marine animals. It has gryphites, and a few detached siliquastra, in common with the Bath and Bristol lyas.

But it seems to claim the flatted ammonite, with a pearly shell as peculiarly its own.

In the lyas we sometimes find vestiges of coal, and it is said, that very thin beds of coal occur, one of which has been traced for three hundred miles.*

XII. THE RED GROUND FOSSILS.

This stratum may be considered as forming a barrier between the animal and vegetable kingdoms, for above it we have only animal exuviæ, and beneath it we see little beside numerous impressions of vegetables, chiefly fern leaves expanded, and abundantly diffused in laminæ, over the surface of the subjacent coal.

Many leaves however are inclosed in small iron nodules, of which they form the nuclei. On breaking these precisely in half, the impression of a leaf appears, and although the nodules are rounded at the edges, they seem not to have rolled, but rather to have been formed on the leaf by corpuscular attraction. Besides these, stems, roots, and branches of various aquatic plants, are found in the argillaceous and silicious schist attendant on coal strata.

In the *pennant-stone*, a schistous rock, containing quartzoze sand, with mica, iron, and much argil, impressions of marine plants abound. My friend, Mr. Harford, has enriched his cabinet with more than thirty distinct species of them, collected on his own estate at Stapleton, near Bristol; and Mr. George Cumberland shewed me nearly as many more.

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* Jameson III. p. 165.

In Cheshire, through which county, as I have already stated, the red ground prevails, rock salt appears, covered by clay and gypsum, in horizontal beds, separated by strata of red marl and clay. It is dug thirty or forty feet deep, solid and pure, and in many places it breaks with a sparry structure, which exhibits cubes. The bottom of the rock shews stratification, but in its top are observed concentric circles, which seem to be the section of a mass composed of concentric spheres, like those of agate.

The beds of salt were not formed by land floods, nor did these deposit the blocks of granite, which are found contiguous to the several beds of clay, marl, and salt.

There can be no doubt, that the salt was deposited when the vallies, in which it appears, were covered by the waters of the ocean.

It is remarkable, that the same red ground, which extends in one continued bed from Exeter, by Somersetshire, to Bristol, and through the kingdom, by Derbyshire to Cheshire and Lancashire, or through Nottingham, by Yorkshire into Durham, should in Cheshire, exhibit the muriat of soda, in Derbyshire the magnesian lime-stone; and in Somersetshire neither of these deposits. No stratum however, varies to such a degree, as this wonderful assemblage of beds, which at present passes under the denomination of red ground, and this, whether we examine the quality, the contents, or the thickness of the several beds. If these should ever be distinctly arranged it will be by William Smith.

XIII. COAL FOSSILS.

Coal may be covered by fern leaves, but in itself extraneous fossils are uncommon. Joints of some species of junque, or bulrush, are occasionally seen, and instances have occurred of fish. On the Volga it contains ammonites, tellenites, and pectinites.*

According to Dr. Hutton, veins of gold, silver, copper, and calamine, have been found in coal mines. Its bitumen is supposed to have been derived from organized matter, chiefly vegetable, and to have been their resin.

Strata of bituminous wood have been found in Italy, France, Germany, Saxony, Bohemia, and Iceland.

The Bovey coal is commonly supposed to be of the same nature; but when burnt it leaves, as I understand, no other residum but argil. It has the appearance of wood, but no trunks of trees nor branches, to the best of my knowledge and information, have ever been discovered, and the fibrous texture is continuous in its extent, which circumstance precludes the notion of vegetable, or indeed any kind of organic structure.

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* *v.* Pallas, S. Tr.

XIV. IRON STONE FOSSILS.

Iron stone appears to have no characteristic extraneous fossils, excepting the leaves already mentioned, which appear in scattered nodules, attendant on the red ground. These are found upon the surface, but in the great mass of iron-stone, which lies between the several beds of coal, I have never yet collected extraneous fossils, either plants or shells.

XV. MOUNTAIN LIME-STONE FOSSILS.

Incumbent on this rock, as may be particularly noticed on Glyddon Hill, near Broseley, and on Wenlock Edge, which overhangs Colebrook Dale, we have a rich assemblage of corallites, encrinites, entrochites, turbinites, particularly the turbo delphinoides, spines of echinites, serpularia, and dentalia.

In the mountain lime-stone we remark, as a distinguished feature, the *encrinites*, whose fragments, in some of its most considerable beds, seem to form the whole substance of the rock.

These exuviæ are not always distinguishable, till we have given a very high polish to the fragment, nor perhaps even then can we discern the most minute fragments, without the assistance of a magnifying glass. Of this wonderful animal Mr. Parkinson has enumerated no fewer than twenty-one species.

Next in importance to the encrinites, are the tubiporites, celleporites, milleporites, madreporites, sertularia, and corallites, either disposed in extensive beds unmixed with other substances, or scattered in abundance through the rock.

These little worms, of which Linnæus enumerates three hundred species, have constructed stupendous mountains of lime-stone in every part of the habitable globe, and in the act of building habitations for themselves, have essentially contributed to the habitations of the human race. In this rock the *anomites* are numerous, and of different species, some with dilated sides, resembling wings, having the larger valve gibbous, the beak thick and curved over the hinge, and the small valve concave. Others have shorter beaks and less dilated sides, but are thicker than the former. Others have the hinge on a straight line, the larger valve very convex, studded with tubercles, and produced in their margin beyond the extent of the lesser valve, which is flat.

Others are quinque lobate, with both valves convex, and longitudinally sulcated. In these the sulci proceed but a small distance from the margin, before they become obsolete. At the back of the larger or beaked valve, is a deep broad furrow. The lesser valve is furnished with an angular projection, divided by its sulci into five.

Others again have convex valves semi-orbicular and longitudinally striated. In these the striæ are strongly marked, close and numerous, the beak of the larger valve is pointed and curved over the hinge, which extends in one strait line the whole breadth of the shell, and the margin is obsoletely waved. It has a convex fold down the middle of the smaller valve, and the larger valve has a concave fold, but scarcely perceptible. It has a triangular aperture in the beak of the larger valve.

By one species I am exceedingly perplexed. When separated into fragments, it has the appearance of having been a camerated shell. I have taken much pains to investigate its nature, and have made drawings of such specimens as are now in my own possession, but I have obtained no satisfaction. The beak is small and curved over the hinge, which is strait. The upper valve is flat, or slightly concave, very small, and hid in the fossil state by the convex part of the larger valve, which is extended nearly one inch beyond the upper valve. It has been denominated by Martin, *Conchyliolithus productus*, and is described as *Anomia testa longitudinaliter striata cardine recto, valvula altera producta cylindrico-convexa altera breva plana.* It appears also to have had the name of *lampas luxuriens.*

Mr. Parkinson has described this fossil with his usual accuracy. His figures in Vol. III. plate 16, figures 9 and 10, are excellent.

These different species of *anomiæ*, are of various sizes, some as big as hazel nuts; others are twelve inches diameter.

Professor Pallas, in his view of the Taurida, deserves commendation for his description of the mountain lime-stone. He says it contains few shells, but abounds with entrochites, milleporites, and other corals. If travellers would thus describe the rocks they meet with by their contents, or to this would add their sensible qualities; their relations would be highly interesting to geology.

The bones procured from Gibraltar and Dalmatia are neither petrified nor imbedded in the substance of the rock, but are merely accidental deposits in its clefts and caverns.

It is remarkable that mountain lime-stone, which, as we have seen, every where borders upon coal, itself contains petroleum. This, in some of its beds, is exceedingly abundant.

This species of rock is rich in veins of lead and calamine. On Mendip hills, and near Exeter, it shews manganese; and in Derbyshire, besides lead and calamine, it abounds with copper. The principal supply of calamine is from the same species of rock in Flintshire.

Mountain lime-stone abounds with iron, and wherever that appears, as at Bristol Hot-wells, and on Leigh Down, it produces the most brilliant crystals of quartz.

The calamine has its appropriate crystals, but instances occur, in which it has occupied the place, and assumed the form of calcareous crystals, which have been decomposed and floated off, precisely as, at Passy, near Paris, Quartz, takes possession of the spaces left empty by decomposed selenite, and then appears in much-admired lenticular crystals.

In Arragon, when the prisms of selenite have been decomposed, their place has been occupied by calcareous spar. Innumerable instances of such metamorphoses occur in mines, and afford much light to the science of geology.

In no part of Great Britain have I seen a *primitive lime-stone*, that is, such a lime-stone as in none of its beds contains extraneous fossils. I have indeed seen many rocks which do not readily exhibit the fossils they contain, unless these have been brought to light by polishing. Alternating with such beds, we find others, in which shells and corals are extremely rare, or which seem to be composed entirely of calcareous paste, as in our lyas, whose fossils are confined principally to its intermediate beds of clay.

In the most perfect of Italian marbles, we have indeed no extraneous fossils, but it does not therefore follow that such rocks are primitive. They are in the vicinity of Granite. They border on basalt, and other volcanic productions. They have not the least resemblance to our mountain lime-stone, or other calcareous rocks, formed evidently by subsidence in water. They are semipellucied and in their fracture have a crystalline appearance.

These circumstances have long since made me suspect the agency of fire, and now the experiments of Sir James Hall confirm my suspicions. He has had the goodness to shew me some of his marble, produced by fusion under pressure, equal in its appearance to the Italian. The term primitive lime-stone seems therefore to be improper, and the reason why no extraneous fossils are to be found in the Carrara marble, may be, that the whole mass of this carbonate has been in fusion. This rock carries native gold and magnetic iron-stone.

Mr. Parkinson has gratified the public by a rich variety of drawings from the mountain lime-stone, as may be seen in his second volume, pl. 1, pl. 2, pl. 3, pl. 4, fig. 1, 2, 3, 7, 9, 10, 11—pl. 5, fig. 3, 6, 9—pl. 6, fig. 1, 2, 5, 9—pl. 7, fig. 10—pl. 15, fig. 1, 9—pl. 18, fig. 4—vol. 3, pl. 6, fig. 7, 8.

Martin, in his work called Petrificata Derbiensia, has given us engravings, executed by himself, of numerous species of anomiæ, found in the mountain lime-stones. Of the curious species called by him *anomites cuspidatus*, we have an excellent engraving in Knorr, p. II, b. IV. fig. 9.

XVI. & XVII. THE SCHIST AND SLATE, THE PUDDING-STONE AND BRECCIA.

These beds have no fossils peculiar to themselves. They claim therefore little attention for marine productions, independantly of the rocks of whose fragments the latter are composed.

XVIII. BASALT AND TRAP.

In these we seldom find organized bodies. Yet Von Buch found pectinites near Valdagna, and Cardites near Brendola. In Auvergne basalt exhibits mytili, with ammonites; and it is remarkable, that in the country of Antrim, flints, the ordinary attendants on chalk, and which seem most frequently to contain some zoophyte as their nucleus, are found in basalt.* Of this my much-lamented friend, Dr. Archer, shewed me an example.

In trap, Mr. Greenough has detected fragments and masses of lime-stone and calcareous spar, fluor, clay, flint, barytes, coal, bitumen, plumbago, zeolite, olivine, feldspat, white quartz, with crystals, and a large nodule of quartz, which, by its numerous depressions, seems to have adapted itself to the form of the inclosing mass, whose cavity must have had protuberances, like blistered copper ore, malachite, or hæmatite. Many of these specimens I saw, and he assured me, that in his researches he had frequently occasion to observe in whin dykes fragments of the rocks through which they pass.

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* Hamilton's Antrim.

The cabinet of Sir John Saint Aubyn contains four perfect crystals of feldspat, found in lava at Drachenfeld, near Bonn.

All these fossils, as I conceive, must be extraneous to the rocks in which they appear.

XIX. GRANITE.

Granite never discovers vestiges of organic structure. It may, indeed, have fissures, and these may be occupied by deposits from the forementioned rocks containing extraneous fossils, but it has none, which naturally belong to it.

Nevertheless Dolomieux discovered masses of calcareous spar in granite. He says, "Cepandant j'ai êtè etonnè de trouver au centre
" d'un ènorme massif de granit, que l'on avoit ouvert avec la poudre
" pour pratiquer un chemin, des morceaux, gros comme le poing et
" au-dessons de spath calcaire blanc tres effervescent, en grandes
" écailles, ou lames entrecroisées. Il n'occupoit point des cavitès par-
" ticulières, il n'y paroissoit point le produit d'une ilfiltration qui au-

" roit rempli des cavités, mais il etoit incorporè avec le feld-spath, " le mica et le quartz, faisoit masse avec eux, et ne pouvoit se rompre " sans les entrainer avec lui. Ce singulier bloc de granite est au fond " de la gorge profonde, qui termine la vallée du Zillerthal, au pied " du Greiner, une des plus haute montagne du Tyrol, & parôit s'être " dètachè de ses flancs, ou etre descendu de son sommet."*

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* Dolomieux Journal de Physique à Paris, Tom. xxxix. Juillet. 1791.

EXTRANEOUS FOSSILS OF OTHER COUNTRIES.

EXTRANEOUS fossils are not confined to the various strata of our island, for they appear in every part of the habitable globe, under the equinoctial line, between the tropics and in the vicinity of both the poles, in the lowest vallies, in deep excavations, and near the summits of the most elevated mountains.

In Greenland the rocks are chiefly granite, with innumerable clefts, mostly perpendicular. These are filled with quartz, garnates, and talc; but near the sea the rock is mountain lime-stone and contains fossil shells.*

In Norway, or rather on its borders and extreme limits, between it and Sweden, is a lofty chain of mountains, running North and South. Other chains, less elevated, run parallel to these; and in the Diocese of Bergen, where the principal marble quarries have been opened, the fossil shells, usually attendant on mountain lime-stone, have been found, and extensive caverns, similar to those of Derbyshire and Mendip, have attracted the observation of the curious.*

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* Crantz, Vol. 1. p. 54.

In Russia, the shores of the lake Ilmen, near Ladoga, are bordered by calcareous rocks, with numerous fossil shells; and Siberia has contributed its proportion to enrich the cabinet of the geologist. The calcareous mountains near the Jaik, have their extraneous fossils; and above Inderski their strata are exceedingly confused, some horizontal, some oblique, others vertical, all much dislocated, and in many places interrupted by vast caverns. The whole country abounds with sea salt, and the clay contains both oyster shells and belemnites. Such fossils are most abundant in chalk, on the Southern hangings of the Valdai mountains. In the marble quarries of Stafonofskoi, in the Ural mountains, which constitute one of the highest chains of central Asia, Professor Pallas discovered pectinites. Near Moscow he found shells in clay. Among these were lobsters' claws, ammonites, chamites, tellinites, terebratulites, and little tubulites, which retain some part of their natural shell, although they are very thin and extremely brittle.† In his Southern journey he found on the right banks of the Volga, near Antipouka, mitilites, bucardites, tellinites, turbinites, volutes and bones, not the produce of the Caspian, but of distant seas, all deposited in quartz sand.

It was to the East of the Ural mountains, on the banks of the Toura, and of the Pischma, which, uniting their waters to those of the Tobol and Tauda, fall into the Obi, that our great Russian naturalist discovered the bones of elephants, or of the mammouth, accompanied by marine productions, such as belemnites and glossopetræ. Similar bones, with teeth, supposed by him to have been the spoils of elephants, appeared also on the Souvarisch, and, not far from Tomakoulskoi, in a thick bed of micaceous clay, under a stratum of iron ore, he found impressions of shells, mixed with sharks' teeth, and wood converted into coal. Here also elephant bones were scattered, and near Tobolsk, which is the capital of Siberia, the same kind of bones are noticed on the sandy banks of the Irtish, more than seventy feet above the level of the River. With them are found vast heads of fish, with teeth, and innumerable tellinites.

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* Pontopidan, Vol. 1. p. 54, 164. † Pallas' Voyage, Vol. 1. p. 19.

Such deposits of the ocean appeared on the banks of rivers, which fall into the Alei; and in every part of Siberia he saw monstrous teeth, and bones of the same animal, with those of the rhinoceros.

Captain Billing, as reported by Sauer, when he had penetrated the Northern ocean as far as the Kovima, met with tusks of the same species in sandy hills.

Poland exhibits extraneous fossils in abundance, more especially in its salt mines, from which the cabinets of naturalists are supplied with some of their best madreporæ and sea shells.* Near Cracow, a crab's claw was found in salt, at the depth of two hundred and forty feet.

The Carpathian Alps, which, dividing Hungary and Transylvania from Poland, rise eight thousand six hundred and forty feet above the level of the sea, are so abundant in salt, that no fewer than two hundred salt works are established on this chain and the lime-stone, interposed between its sand-stone and granite, is full of petrifactions.*

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* Chaptal.

At Shemmiz, in lower Hungary, a chain of mountains unites with the Carpathian Alps. In the inferior range of these mountains, Baron Born found grey lime-stone, over which, at a much higher level, madreporæ appear in Zinopel. But in a journey from Shemmiz to Temeswar, at Osen, on the Danube, opposite to Pest, he observed a porous lime-stone filled with chamæ, turbines, and pectens.†

In the heart of Germany extraneous fossils are equally abundant. On the plains of Westphalia, between Dorsten and Haltern, elephants' teeth with ammonites and belemnites appear in sand, and in the road from Hanover to Gottengen, are seen lime-stone charged with ammonites.

The vicinity of Paris, particularly the sand bed, of Grignon near Versailles, and of Courtagnon near Rheims, which lies over the clay and chalk, yielded to M. Defrance, six hundred species of shells, of which more than three hundred and sixty are non-descripts. In both these places some of the same species are found as in Hordwell cliffs, at Walton, in Essex, in Lombardy, and in the Vicentin. Those of Hordwell are described by Brander and Dr. Solander, those of Walton by Dr. Menish, and those of the Vicentin by Albert Fortis.

Near the Bois de Bologne, at Paris, the quarries are subterranean at the depth of eighty feet. They abound in turbinites, the turbuculated *cerites* of Lamarck, and I apprehend are in the same stratum as I have described in Essex.

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* Townson's Hungary. p. 401.

† Baron Born's Travels.

The alluvial strata of Piedmont and Lombardy, yielded to the researches of M. de Luc shells more brilliant than those of the sea coast.

In Turenne M. de Reaumur observed, and was the first who directed our attention to, a tract of country, nine leagues square, covered twenty feet deep by shells, without the least admixture of other substances, and whose analogues have never yet been found on the shores of the adjacent seas. The whole bed is horizontal, and every shell lies flat as it would lie at the bottom of the ocean. M. de Saussure, near the Pont de Gard, met with the pecten striatum and other bivalves in horizontal strata.

Every part of France is rich in fossils. I found an ample supply for my cabinet in Picardy; in Champagne, more especially at Dijon, and at Tonnere; in Burgundy, particularly at Challon; in the mountains at the borders of the Rhone; and above all in Languedoc. In the most elevated situation at Montpellier, near the Perou, I discovered a bed of the beaked oyster, about eighteen inches thick, without the least admixture of any other substance, all in the highest state of preservation, and as perfect as the recent shells. Nor far from thence in the Fauxbourg Bontoné, I picked up echinites, with pectinites, large, beautiful, and deep ribbed. Near Aix, the gypsum quarry abounds with fossil fish, which are not to be discovered recent in the adjoining sea, and with these are numerous palm leaves.

At Pezenas I observed a venerable castle of the Montmorency family, the materials of which were hewn out of the rock, on which it proudly stands. This appears to be a mass of shells, such as turbinites, and cardites, with a calcareous cement. And at Beziers I found lime-stone, containing these with many other species of shell, among which I particularly noticed some beautiful mytilites and many deep ribbed pectinites.

I traced similar extraneous fossils all the way to Perpignan, and through the whole tract of the Rousillon, till I arrived at Belgarde.

On the Pyrenees themselves I lost sight of them as soon as I approached the granite; but M. Ramond, in a letter to H. M. Williams, says—"I arrived half way up Montperdu, which may be regarded as the Montblanc of the Pyrenees, and which hitherto no " one had approached. There I met with glaciers not inferior to those " of the Alps. But that which the Alps never can exhibit, is the " sight of secondary calcareous mountains, raised to such stupendous " height, and the bones of quadrupeds mixed with shells and zoophytes, " the burying-place of the anti-diluvian world, elevated nine or ten " thousand feet above the level of the sea."* Here Professor Link and M. de la Perouse found marine productions at the height of ten thousand five hundred and seventy-eight feet.

In the most elevated mountains of the Asturias I noticed extraneous fossils; and met with not a few in Cadiz, Murcia, Alicant, and Tortosa. For a particular account of these, I must refer the reader to my travels, in which I never lost sight of this most interesting object.

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* H. M. Williams's Tour in Switzerland, Vol. 2. p. 285.

From Spain I would turn the attention of my reader towards the Northern Alps.

In rising up from Burgundy through Franche Comtè, and advancing towards the Alps, we meet with seven chains of mountains, each higher than the preceding, till we arrive at the Jura chain, which is more than two hundred miles in length, and nearly fifty miles in breadth. Of this the most elevated peak is four thousand feet above the Lake of Geneva. In this range the country round Basle, Neuchatel, and Besançon, and the whole extent of Jura, even to the summit of Mount Grenier, which is eight thousand three hundred and forty-six feet above the level of the sea, abounds in fossil shells.

South of Mount Jura, the Lake of Geneva stretches East and West, and to the South of this we have Mount Saleve, whose most elevated peak is about three thousand feet above the surface of the lake, and nearly four thousand two hundred feet above the level of the sea. This mountain is altogether calcareous, and contains gryphites, anomites, pectenites, entrochites, and corals, of which I collected some beautiful specimens. To the South East of Saleve, at the distance of about five leagues from Geneva, is Mount Brezon, forming part of a chain, which is considered as the first of the Alps. Like the other chains, it runs North East and South West, and like them, as far almost as Mont Blanc, it is calcareous. Its scarp is precipitous and looks toward the lake, and its superior strata sink rapidly towards the central chain. The same observations will apply to the subsequent range, of which Mount Vergy forms a part. Beyond these, very high calcareous mountains rise, and turn their backs on the preceding chains. In the intermediate valley, near the Chartreuse du Reposoir, is lime-stone, inclosing anomites, turbinites, and ammonites, with large chamites full of sharp quartzose sand.* Near Sallenche petrified oyster-shells are found more than seven thousand feet above the level of the sea.

The distinguished naturalist, to whose researches we are indebted for much of our knowledge of the Alps, has judiciously remarked, that the fossils of the greater and of the lesser *Emme* do not come from the mountains of Entlibuch, in which those rivers rise, but from mountains more to the North; therefore these fossils were not brought by them, but must have been deposited whilst the vallies in which these rivers run, and all the circumjacent mountains, were covered by the waters of the ocean.

For an account of the Southern Alps, we must have recourse to Ferber; and from him we may learn the arrangement of the strata. According to him the lowest consists of innumerable beds, containing casts of tellina, and other bivalves. Over these he observed white compact lime-stone with oysters, then small beds of pure oolite, then red oolite with ammonites, covered by white oolite, of which each bed carries its peculiar species of shell. The uppermost bed has flints. In the slopings of the lime-stone mountains are hills containing—

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* Saussure, tom. 1.

1. Near Vicenza, ostreæ, pectines, chamæ, arcæ, nautili, and glassopetræ, with different species of madreporæ.

2. At St. Vido, immense quantities of oysters.

3. At Grancona, echinites, balani, and nummularia.

4. At Ronca in the Veronese, ostræ, anomiæ, murices, and bones.

5. Monte Bolca, near Verona, has yielded to the researches of Volta impressions of fish in great abundance. Of these, twenty-seven species are European, thirty-nine Asiatic, three African, eighteen South American, eleven North American, and seven fresh water.*

6. Near Recoara, the calcareous strata yield entrochi, gryphites, anomiæ, and spines of echinites.

De Luc was the first who ransacked the Southern Alps, and to him we are indebted for most interesting descriptions.

Near Maestricht, at Fauquemont, the hills are of calcareous sand, and rock, with shells covered by vitresscent sand. About Tongres are strata of chamites and nerites; between these two districts, at St. Peter's Mount, is a stratum of shells, madreporæ, and corallines, and belemnites over a stratum of echinites.

Parallel to this mountain is another, called Can, in which the same strata appear with oysters and scales of turtle, attended by a vein of coal covered by slate, in which are impressions of plants, but such as are foreign to Europe.† Faujas de S. Fond has published a most magnificent work on this celebrated mount, near Maestricht.—He particularly describes the head of a supposed crocodile, with the jaw and vertebræ of a tortoise, sharks' teeth, and agatized wood, perforated by worms. Among the shells have been discovered the ostrea jacobæa of the Mediterranean, the pecten pleuronectes of China and Japan, with the echinophora digitata of Rumphius, which inhabits the Indian ocean.

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* Saussure, § 1535.

† De Luc Hist. de la Terre, tom. IV. p. 120.

Professor Camper has enumerated, with the corals, madrepores, belemnites, orthoceratites, alcyonia, echinites, turtles, and the teeth of of some physeter, or respiring fish, supposed, but without foundation, to have belonged to a crocodile.*

The Appennines, in Italy, are principally mountain lime-stone, with its peculiar fossils

Ætna has strata of clay with marine productions, which appear at the height of two thousand four hundred feet above the level of the sea†

Caucasus has its pectinites and tellinites.‡

In Minoca, Armstrong took notice of lime-stone, covering slate, as that does the granite, and containing teeth, supposed to be of the shark, from one inch to two and a quarter long, and as perfect as when recent. With these he found echinites, such has have never been discovered in the adjacent seas, and many species of bivalves, chiefly ostreæ, cardia, anomiæ, trochi, buccini and buffonites.§

Malta contains the same species of extraneous fossils as Minorca, and in its chalk it carries large teeth of the shark, resembling those near Paris.

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* Phil. Trans. Vol. 76 p. 443.

† Kirwin's Geol. Ess.

‡ v. Pallas. S. Russ. p. 516.

§ Armstrong's Minorca.

Syria has not been much explored by experienced naturalists; yet on the Castravan mountains, which are a part of Libanon, Dr. Shaw discovered a white schist, containing a number and great variety of fish, so well preserved, that the smallest strokes and lineaments of their fins and scales are easily distinguished. Among these he collected a beautiful specimen of the squilla, which though the tenderest of the crustaceous tribes, yet had not suffered the least injury, and consequently was not conveyed by torrents, but must have been quietly deposited in deep water.

In Arabia fossil shells are rare, yet at Corandel, Dr. Shaw picked up one echinite of the discoide kind, and a few chamæ, and between Suez and Cairo, as indeed all over the mountains of Lybia, he saw numerous bivalves, echinites, and turbinated shells.*

In Upper Egypt, about Siout and Panopolis, now called Echmin, the rocks are calcareous and replete with fossil shells.†

Jamaica has marine productions on its most elevated mountains, and Bryant Edwards has particularly stated, that the fossil oyster, which is there abundant, is a native of our Western coast, and is never met with in the circumjacent seas. In the year 1778, Dr. Clarke found immense collections of corallines, on the blue mountains, three thousand feet above the level of the sea.

When I visited Don Antonio Ulloa, in Cadiz, he shewed me his cabinet of marine productions, collected by himself, near the summits of some high mountains in *America*, and he informed me, that on the quicksilver hills, surrounding Guaneavelica, at the height of one thousand four hundred and twenty-two feet above the level of the sea, he had procured petrified wood, with abundance of pectens and other bivalves, of different species, all in the highest state of preservation. Near the same spot he found pudding-stone.

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* Shaw's Travels, p. 344, 444.

† Sonini's Travels in Egypt.

M. de la Condamine states, that in the high mountains of Peru, he found no *marine productions*, nor was it possible he should, because the elevated peaks chosen for his stations, are composed only of Porphyritic rocks, which are ten or twelve thousand feet in depth. But Alonzo Barba particularly relates with much wonder and amazement, that he saw innumerable petrifactions of sea shells in his way from Petosi to Oronesti;* and Humboldt found sea shells at Huancavelica, fourteen thousand one hundred and twenty feet above the level of the sea. He particularly states, that in a trench sunk one hundred and sixty feet deep, in order to carry off the floods from Mexico, elephants' bones are found. In this trench he counted twenty-five beds of hard clay, separated by as many beds of marl, the whole incumbent on porphyry. Not only in Mexico, but in Peru and Chili he discovered teeth of the mammouth and of the elephant.

Clavigero tells us, that on the summit of Mount Dezcabezado, petrified marine substances are abundant, five hundred miles inland, and elevated three miles above the level of the sea.† Indeed Molina found there numerous fossil shells, as he informs us in his account of Chili lately given to the public.

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* Vol. 1, Cap. 17.

† Clavigero's Mexico, by Cullen, q. 250.

In Timor one thousand eight hundred feet above the level of the sea, on the summits of the highest mountains, Peron saw shells in the middle of madreporic masses mostly silicious, but some calcareous, and among them fossil tridacnes of Lamarck, five feet long which served as hog troughs.* And in Wager Island, on the coast of Patagonia, Capt. Byron observed beds of shells, near two feet in thickness, on the summits of the highest hills.†

Most of these marine productions are deposited by families, not mixed and jumbled together in confusion, but sorted and disposed with striking regularity, so as to confine the several species to their proper beds as in the ocean. And all the strata, in which they appear, are laminated so as distinctly to evince, that the deposits were successive. Wherever fern or other leaves are seen, they appear in the same direction with the stratum in which they are contained, whether horizontal or inclined, and thereby prove that they floated quietly in water, and were quietly deposited with the attendant slime.

I have already stated that the analogues of primeval shells do not exist in the neighbouring seas, nor in the same climate. Such of these as correspond to recent shells invert their climate, but many species have never yet been detected in the ocean.

Such shells as are found among alluvial gravel, are frequently much broken, and their fragments appear with rounded edges, but of those which are deposited in their proper beds, many are perfect;

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* Peron's Zoological Facts, 1804.

† Byron's Narrative, 1678.

with their points and edges exceedingly acute, even where the shells are both large and brittle. I have some specimens which mark the several ages of attrition. In these, many shells on the surface of the specimen, are perfect and unbroken, and incumbent on large fragments, as these are on smaller, till at last nothing appears at the base but calcareous sand.

Shells are found not only in the horizontal strata, and in those which are moderately inclined to the horizon, but also in those which are vertical. Thus for instance, the strata of schist rock under the citadel at Coblenz, are almost perpendicular; yet they contain terebratula, with fragments of shells lying flat in the direction of the strata. The same observation will apply to the rocks of Lahnstein.*

No human bones, comparatively few remain of quadrupeds, and none of birds have been found in a state of petrifaction. In the cliffs at Walton, in Essex, a great variety of bones are found, and teeth, with tusks of the hippopotamus and elephant, both infantine and full grown, evidently petrified prior to their being buried in this bed of clay, in which they are now discovered, for part of the calcareous stratum in which they were originally deposited, still adheres to them. This transposition therefore was accomplished in deep water, and was not produced by land floods.

From the facts already stated, it appears that all the strata we have noticed were formed whilst that portion of earth, now inhabited by man, was for ages covered by the waters of the ocean.

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* De Luc.

But since ponderous substances, subsiding and subject to the incessant fluctuation of the containing fluid, must form a level floor, it is evident that all our strata must have been originally horizontal, or nearly so, and that their inclined position must be regarded as a dislocation.

This dislocation, however, has been effected for the best of purposes.

OF SPRINGS.

OF all the countries with which I am acquainted, no one is so interesting to the geologist as the vicinity of Bath, because in no other are so many strata exposed to view. Neither is there any other country enriched with such a number and variety of *springs*, for within five miles we have six distinct sets of them, independantly of the hot springs, by which the city is distinguished. But that which most increases the advantage of this situation is, that in each set of springs we distinctly see both the filtrating stratum from which these springs proceed, and the impervious bed of clay on which the water glides, before it issues in the form of springs.

This it is which makes Bath an excellent school for civil engineers, and I may add, for lawyers; if the former wish to discover hidden supplies of water, and the latter would qualify themselves to settle the numerous disputes which either now subsist, or may arise respecting *springs*.

Immediately round Bath we discover three sets of springs, altogether unconnected with each other.

The uppermost of these, breaking out at the foot of the *great oolite*, may be observed near the summit of the hill, as you ascend to Lansdown, where a drinking trough is placed, near to which numerous rushes mark their exit. They appear again on the Northern hanging of the hill, beyond the monument; on the West above North Stoke; on the East above Langridge; on the new Gloucester road above Swanswick; on little Salisbury hill all round its summit, particularly in the South, the East, and the North East; on Banner Down; near Coldhorn church; on Farley Down, above Bath Ford; and near Farley castle; on the Eastern declivity of Claverton Down; and in the way to Stokebridge, where a drinking trough is placed, and where, by the road side, the gushing stream breaks out under a ledge of rock on yellow clay. They appear at Bradford, Tilsford, and Murhill; at Limply Stoke, and Coombe Down; near the summit of Anthony Hill; below the quarries, which are to the West of burnt house gate; below the Cottage Crescent; and at South Stoke. In a word wherever the bottom beds of this rock are found, the springs come forth, and immediately below this level rushes never fail to be produced. So abundant is the supply of water in this stratum, which, as I have stated, dips S. E. and sinks out of sight at Bradford, that a level driven above the lock, and extending to the S. W. would discharge a rapid stream into the canal, for the supply of all its wants. This stratum of water now runs under ground and is lost.

At a lower level the springs of the bastard free-stone, which flow on the surface of the blue marl, attract our notice between Liliput-

Hall and Tracey Park; below Toghill House, in the way to Wick; above Langridge; at Bathwick; at Bathford; and Bathampton; at Claverton; to the North of Stoke; near Stoke Bridge; under the Lansdown and Camden Crescents; in Holloway; at English Combe; near the summit of Stantonbury Hill; at Coombe; at Lincombe; and at Combe Hay. We have the same springs at Middle Hill and at Cheltenham, impregnated in these places by peculiar salts.

The third set of springs belongs to the lyas beds. These break out to the West of Twiverton; at Weston; in Sweetwell Lane, near Newton; at Ashton Hill; at Bitton; at Wick; in Tracey Park; and at Hamswell, below Lansdown. In a word they attend the lyas beds, wherever these appear.

The most abundant springs of Somersetshire, are those of the millstone bed in the red ground. These the coal adventurers find extremely troublesome, after they have either diverted or subdued the lyas springs beneath which they flow. Near Bath, at Newton, Radstock, Camerton, Bitton, Puckle-Church, and Bath Easton, they are found in depth, but do not appear upon the surface.

I apprehend that these are the springs which supply Maiden Bradley, Mells, Nunney, Cranmore, Ashwick, Guerney Slade, Binegar, Redhill, and Chewton Mendip, and contribute largely towards our vernal floods at Bath. They no where break out to the South-east of the line I have here described: but they are found in depth by miners, and invariably sink to the South-east. Consequently this stratum of water, like all others, from which our springs proceed, must descend till it finds a vent, either in the ocean, or in the great abyss.

Such are the lowest springs with which we are acquainted in the vicinity of Bath.

As we rise to the South-east, when we have left all these springs behind us, we catch, in due succession, the springs of the *forest marble* and of the *calcareous grit* above Bradford, at Farley Castle, Hinton, and Norton. Then, at a higher level, we find the springs of the *cornbrash*, at Staverton, Trowbridge, Hilperton, Norton, Woolverton, Road, and every place where the corn brash is found. But the most abundant and permanent springs issuing from this stratum are seen at Norton Mill, near Malmsbury.

The springs of the superior strata of *Calloway*, or *Kellaway rock*, of the *coral rag*, of the *calcareous grit*, and of the *Calne oolite*, break out beneath these rocks.

The springs of the *green sand* appear in the meadows round Beauchamp Stoke, Patney, Lydeway, the Cheverells, and Market Lavington. Those of the *grey sand* break out abundantly, perhaps at Calnstone, and certainly in Drew's Pond, near Devizes, and at Pottern; and may be traced from thence to the *Black Dog*, at Standerwick. These are the springs of Meestham and Darkin, in Surrey.

The *chalk* throws out its bottom springs through a stratum of porous rock, consisting of sand and minute gravel, loosely cemented by chalk, as may be seen at *Calnstone*, where, proceeding from the bottom of the chalk hills, it is immediately so abundant as to turn a mill. The same set of springs may be traced all the way to the S. W. as far as Lulworth Cove, in Dorsetshire. To the N. E. they follow the line of chalk through Bedfordshire to the English channel.

The superior chalk springs all flow through strata of nodulated flint, and sink with them to the South East.

The pure Malvern springs, I am persuaded, originate in the red ground, for they break out in the South East side of the hill, in what I conceive to be its bed of sand.

All these springs issue from regular strata of water, which are formed by filtration through either sand or porous rock, and flow each on its subjacent bed of clay. Hence it is, that, like these beds, they generally dip to the South East, and issue commonly in that direction. Yet, from what has been stated, it is evident that they must be affected by the dislocation of the strata with which they are connected, and therefore occasionally either break out laterally, or with the dislocated strata invert their dip.

These circumstances I had occasion to observe in our Kennet and Avon canal; for whenever we passed along a filtrating bed; in the space of five hundred yards we frequently cut five hundred little trickling rills, and never failed to find water issuing from ten thousand pores.

Should the filtrating rock, with its attendant strata, be disrupted and displaced by faults, its water could not descend on the subjacent bed of clay and issue through ten thousand pores, but must be intercepted by the dislocated portion of the strata, and, being collected into streams, must issue in the form of *springs*. Of such we have innumerable examples in the hills round Bath.

To understand this part of the subject, we must consider that fractures in rock strata may have taken place in various ways; for an extensive portion of a stratum may have been either raised or depressed, so as to form a trough. Again the rupture may be perfect, and either one part may have risen, or the other may have sunk perpendicularly. But instead of rupture, there may have been merely subsidence, so as to form a basin, which has become a subterranean reservoir.

In cases of rupture, these may have taken place either in the superior or the inferior part of the stratum, or in its sides, or diagonally in all directions. When, if ever, W. Smith shall be enabled to publish his inestimable discoveries, and his observations upon *troughs*, the science of drainage will attain perfection.

It sometimes happens, when several crops unite to form one great scarp, that all the rock strata are fractured, and sink towards the subjacent valley. In this case the several strata of water, attendant on the rock strata, sink with them, invert their natural dip, fall to the North West, and issue in that direction. This may be particularly noticed at Derry Hill, near Calne. In a word, springs follow the dip of the rock strata, whatever that may be.

Strata of water in their descent are contained each in its filtrating bed, confined between two impervious beds, and, as they are inclined plains, should the uppermost be perforated, a spring must issue, and by the laws of hydrostatics, rise upwards till it has found its proper level. This accounts for the rapid rise of water wherever this occurs in wells, the instant the upper rock has been either broken or bored through.

Round Bologna and Modena, the wells are usually sunk sixty-three feet, then bored five feet, at which depth the water springs up and runs over; or, even in the driest season, fills them to the brim.

In like manner the inhabitants of lower Austria are obliged to perforate a rock before they can get water, and by this expedient Cassini made a fountain at the Castle of Urbino, which threw up a jet five feet above the surface of the ground.*

When our Government wished for water to supply the barracks between Cowes and Newport, in the Isle of Wight, the well-diggers sunk in a bed of clay two hundred and sixty-five feet, without success, but hearing, beneath, the sound of a rushing stream, they bored fifteen feet, and then hastened their retreat, which however they with difficulty effected. The water then rose two hundred and fifty feet in the well, and so continues.

At Sheerness, in the year 1781, the King's well was sunk, by means of kurbs, through clay, quick-sands, and gravel, three hundred and thirty feet, when, upon boring, the whole bottom of the well blew up, and it was with difficulty the workmen escaped the torrents of water that followed them. The issuing stream was mixed with sand, which ascended forty feet in the bottom of the well, at which height it still remains. The water rose in six hours one hundred and eighty-nine feet, and in a few days came within eight feet of the top of the well. It has since been carefully analized by a chemist, and found perfectly good for every purpose; and it is presumed the quantity will be equal to every demand of public and private use at that place, as there has been ever since it was first discovered, a constant drawing of water, and it has hitherto been found impossible to lower the well more than two hundred feet. There has consequently always been a depth left in water of one hundred and thirty feet.* A. D. 1784, this well had one hundred and eighty feet of water.

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* Ray on the Creation, p. 39.

We likewise learn from the Philosophical Transactions, that in the year 1797, a well was sunk at Norland-house, two hundred and thirty-six feet deep without finding water. The workmen then bored through quicksands twenty-four feet, making in all two hundred and sixty feet. The borer then penetrated a rock and met with water, which rose immediately, mixed with sand, one hundred and twenty-four feet, and soon after one hundred and nineteen feet more, in all two hundred and forty-three feet. The next day the water was drawn off, and in a short time it rose again to within seventeen feet of the surface, but the sand was found to have risen ninety-six feet, and, when the water was again drawn out, remained perfectly hard. This was soon extracted to within thirty-six feet of the bottom, and the water rose immediately, as before, to within seventeen feet of the surface: but the sand came in again. After infinite labour and much time in getting rid of the sand, the top of the well was raised eighteen inches, and yet the water ran over and discharged forty-six gallons in a minute. In a similar manner the whole of London might be supplied with water.

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* Phil. Transactions, vol. 74, A. D. 1784.

Dr. Shaw mentions a district called Wadreag in Africa, in which the inhabitants dig wells of twelve hundred feet through sand and gravel, till they come to slate, on breaking through which the flux of water rises so rapidly, that the utmost speed is needful to escape from it.

In the trial for coal at Bath Easton the adventurers sunk through the blue marl seventy yards without being molested by water, but no sooner had they penetrated the lyas, than the water rose in their pit and ran over its mouth. Unable to proceed in sinking their pit they erected a powerful engine and then bored through the red ground into the mill-stone. Immediately the springs of this bed rose up and overpowered their engine.

Should the Kennet and Avon Company take a hint from the experience of these unfortunate coal adventurers, and, in Claverton, sink through the blue marl into the lyas, and then into the mill-stone bed, there is a probability that they will have the same springs, for a never-failing supply of water in the continuation of their canal between Bath and Bristol.

What has been here brought forward respecting the rise of springs, will account for *quick sands.*

Were the confining strata water tight, that is, free from fissures and from faults, the filtrated stream would either descend between the strata to the centre of the earth, should they extend so far, or would be discharged at their termination, wherever that might be. But supposing some fissure to be made in the uppermost of these confining strata, a spring would rise with a degree of force proportioned to the depth of the fissure, and the copiousness of the issuing stream; and should these be nearly equal to the pressure of the incumbent mass of incoherent materials, a quick-sand would be formed. In similar circumstances, should the incumbent matter be peat, a bog would be the consequence.

When it happens that ruptures in two or more strata have a communication, their waters will mix together, and the united spring, when tapped, will partake of both, whatever their impregnations or qualities may be. But should either of these be dry in summer, the other will retain its proper character unmixed. This circumstance accounts for a fact, which has been frequently observed, that wells, which yield good water at some seasons, are vitiated in others.

When ruptures in two or more strata have no direct communication, their waters may form separate springs. This circumstance I had the good fortune to see at Bath, when the new building was constructed, over the springs of the Cross Bath, I particularly noticed hot and cold springs issuing within the space of two or three lug of ground, in such a manner that the cold springs were obliged to be separated from the hot ones, and, not being suffered to issue on the spot, were separately conveyed into the river Avon. This was done in order to prevent a mixture of the two together. Such phœnomena are not uncommon. In the Philosophical Transactions,* we have an account of warm and of cold water, issuing out of the ground within the compass of half-a-yard; and at Buda, one hot spring rises in the midst of a pool of cold water.

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* No. 8, p. 133, No. 407, p. 22.

At Bath, as Mr. Wood informs us, five springs, which had never been seen before, broke out and continued to yield an ample supply of water. In the King's Bath, the springs send forth one thousand and sixty tons of water in twenty-four hours, and as the fall from thence into the river is seventeen feet, the ancients availed themselves of this supply to turn a mill.

The copiousness and permanence of springs depend on the extent of country with which they are connected, and thickness of the filtrating strata through which they flow. This we see distinctly in all the springs round Bath; in those of the *great oolite*, of the *bastard free-stone*, and of the *lyas*, of which the first and last are not only the most permanent, but the most abundant, as may be observed at Claverton and Weston. When we rise up to the thin stratum of the *corn brash*, as at Woolverton and Road, the springs are transient as the vernal storm.

But when we arrive at the enormous beds of sand beneath the chalk, rivers gush out at once from the incumbent mass of filtrating materials, as may be seen at Calnstone, at Market Lavington, at Devizes, and at Pottern.

When we sink wells in the chalk of our Wiltshire Downs; we never fail to find springs proportioned to the thickness of the bed of flints, in which they flow, and to the tract of land which they can drain.

Intermitting springs are not uncommon in various parts of Europe. These often originate in subterranean basins. The nature of these will occur to every one, who has paid attention to what I have said respecting strata and their dislocation, and of coal fields, which, in fact, are basins. For, supposing the filtrating stone strata to have subsided through any given extent of country, a basin will have been formed, and as the stone strata universally repose on clay, a subterranean reservoir will be the consequence. Now when this becomes replete with water, and begins to run over, a syphon will be established, and the spring will discharge itself as long as the supply continues, and cannot return again till the basin is replenished. Basins, however, do not produce intermitting springs, if sufficient fissures are wanting. In such cases, the sagacious geologist may find ample scope for his peculiar talents, and by a well-directed drift may obtain a copious supply of water, both for use and ornament.

All these springs issue from their beds by the force of gravitation, and are governed by the well-known laws of hydrostatics.

But other springs there are, which are produced by the pressure of elastic vapour. Such probably are the *hot springs* of Thermopylæ, of Bath, Buxton, and Matlock, with numerous springs of the same kind in the granitic provinces of Spain and Portugal, and such undoubtedly are those of Iceland.

The little spring in Reikum, that is, in the Reeking Coombe, or Smoking Valley, proceeds from a well of about six feet diameter, in jets, which sometimes burst forth every minute, and rise from about four or five, to twenty and thirty feet high. Another fountain, not far from this, has jets of equal height, which, like the preceding, continue about one minute, but with intervals of five minutes. In others, the jets appear at irregular intervals of an hour or less, and continue only a few seconds. In Haukadal, thirty-six miles from Heckla, a circle of two miles has more than a hundred springs, some in the plain, some on the sides of the hills, and others on their summits.

The *geyser* (that is, the *gusher)* springs have intervals of from fifteen to thirty minutes. The *roaring geyser* is incessant, with jets of thirty or forty feet. The *great geyser* issues through a cylinder, seventy feet deep, and eight feet and a half diameter, with a funnel of fifty-nine feet diameter. Its jets occasionally rise ninety-six feet high, and are repeated every five minutes, after considerable shocks. Its temperature is 212°. The new geyser has a pipe forty-six feet deep, by six feet diameter, and throws water by jets one hundred and thirty-two feet high. These fountains are mentioned by Saxo Grammaticus, so early as the twelfth century.* The Uxahver, in the North of Iceland, is said to equal this in magnificence.

In all my travels, both in France and Spain, I have constantly remarked proximity between hot springs and granite. And in Portugal, where they are most abundant, the mountains from which they issue are chiefly granitic. Indeed, when such springs issue from either sand or lime-stone, the heat is moderate. At the Cape of Good Hope, the hot springs are of the boiling heat, and throw up quartz crystals.†

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* v. Edinb. Phil. Trans. vol. 3.

† Barrows Travels.

At Cannia, in Ceylon, the heat is only 106°, at Thermopylæ 113°, at Matlock 62°, at Buxton 82°. At Bath it varies at the different pumps, but in all the springs it is 116°.

We are not able to calculate either the distance or the depth from which such springs proceed. Dr. Shaw, in his travels through Northern Africa, has remarked that some of its large copious rivers have their sources in extensive plains, far removed from any chain of mountains, and in a country where little or no rain falls. He imagines therefore that these fountains are derived from the great abyss.

Is it possible here to overlook the bounty of Providence in these wonderful contrivances, for the unremitting supply of water to answer the various purposes of life?

Had the strata been all porous; every shower of rain, even the dew had sunk down to the centre of the earth. To prevent this evil, every filtrating stratum has its bed of clay. But had these alternate strata of rock, or sand and clay, been horizontal; the whole produce of rain and dew had been retained to form either one wide expanse of water, or a bed of mud unfit for the habitation of the human race, and this globe would have been superficially restored to its chaotic state, "When earth and air and water were in one."* By the inclination of the strata, the filtrated water descends on a bed of clay, till some fissure, or some extensive fracture gives it an opportunity to issue in the form of springs. We may yet further admire the wisdom here displayed, in the relative position of the several filtrating strata of the earth. The uppermost springs are formed by calcareous and silicious strata, and are therefore salutary, whilst the more soluble and noxious minerals, with their deleterious streams, are hid far beneath our feet in the bowels of the earth. Between these come the springs which are medicinal.

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* Dryden's Ovid.

The royal Psalmist, in surveying the wonders of Creation, does not overlook the admirable contrivance for providing a supply of fresh water, by means of springs. In this hymn of praise, his machinery is most magnificent, his conceptions most sublime. All the most powerful agents in nature are brought forward, and obey the voice of their Creator, not for the destruction of his creatures, but for their comfort and support, by never-failing supplies of limpid streams, which issue incessantly from the mountain springs.

PSALM CIV.

1. Awake, my soul, to hymns of praise,
To God the song of triumph raise.
O! cloth'd with majesty divine,
What pomp, what glory, Lord, are thine!

2. Light forms thy robe, and round thy head
The heav'ns their ample curtain spread.

3. Thou know'st amid the fluid space
The strong compacted beams to place,

That proof to wasting ages lie,
And prop the chambers of the sky.
Behold, aloft, the King of Kings,
Borne on the wind's expanded wings,
(His chariot by the clouds supplied)
Through heaven's wide realms triumphant rides.

4. Around him, rang'd in awful state,
Th' assembled storms ministrant wait;
And flames, attentive to fulfil
The dictates of his mighty will.

5. On firmest base uprear'd the earth,
To him ascribes her wond'rous birth.
He spake; and o'er each mountain's head

6. The deep its wary mantle spread:
He spake; and from the whelming flood
Again their tops emergent stood;

7. And fast adown their bending side
With refluent stream the currents glide;
Aw'd by his stern rebuke they fly,
While peals of thunder rend the sky;

8. In mingled tumult upward borne,
Now to the mountain's height return;
Now lodg'd within their peaceful bed
Along the winding vale are led,

9. And, taught their destined bounds to know,
No more th' affrighted earth o'erflow;

10. But obvious to her use (their course
By nature's ever copious source
Supplied) refresh the hilly plain,
And life in all its forms sustain.

11. Here, stooping o'er the river's brink,
The herds and flocks promiscuous drink;
There, 'mid the barren desert nurst,
The wild ass cools his burning thirst;

12. While fast beside the murm'ring spring
The feather'd minstrels sit and sing,
And, sheltered in the branches, shun
The fervors of the mid-day sun.*

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* See Merrick's Version of the Psalms.

OF VALLIES.

ALL the strata, I have described, though now interrupted by vallies, coombes and dingles, were probably once continuous.

These vacuities were not occasioned by the rivers, which usually are found in them, because rivers are derived from innumerable springs, uniting their little rills into rivulets, as these combine their tributary streams to form the rivers. Unless there had been previously a rupture and dislocation of the strata, such as we observe in coombes and dingles, there could have been no springs to form the rivers.

Every country abounds with coombes, in which are no streams. These therefore must have been indebted for their formation to some other cause than streams, a cause which I shall hereafter endeavour to point out.

Vallies and their rivers sometimes cross the measures of the country, precisely as mineral veins are apt to do. But very frequently they run parallel to the strata, and not uncommonly the river forms a separation between two strata, gliding on the back of the one, and confined in its channel by high cliffs of the other, as between granite and schist, or schist and lime-stone, or any other given strata; which may be observed, in a most striking manner on the banks of the Wye and in the Severn, on whose deep channel we look down from the crop of our great free-stone rock, leaving the chalk hills behind our backs.

When rivers flow in level countries, or such as are occupied by hills, bounding wide and extensive vales; shingle constantly appears in excavations, even at a considerable distance from their beds. This cannot have been created by the stream, for rivers form no shingle; and frequently the most perfect, yet the most brittle shells, appear bedded in sand immediately beneath the shingle, as I have particularly noticed in the vale of Pewsey, through which the Avon flows. Shingle is produced by that kind of attrition which is found on the sea shore, and occasioned either by the flux and reflux of the tide, or by some other operating cause equivalent to it. The shingle, therefore, however formed, and these shells, must have been deposited together in deep water.

On the East of Mont Blanc are two deeply excavated vallies, called the Allée Blanche, running from North East to South West, nearly in one line from the Col de la Segne and Lake Combal, to the Col de Ferret. In the centre of this line, the two streams by which these vales are watered unite, and form the Doire, a little river which, running from the North, and traversing all the Southern chain, empties itself into the Po, and with it falls into the gulph of Adria.

Here we have a most interesting spot for the geologist.

To the North of these extensive vallies the granitic mountains raise their heads, and look towards Mont Blanc. Against these repose first, the schistose, then the calcareous mountains dipping South East, almost vertical at first, but in proportion as they increase their distance from the central chain, they become flatter and almost horizontal. Thus they crop out to the North West, and their extended scarps, highly elevated, look towards the more elevated granite, and form deep vallies. In one of these between the primary or granitic, and the secondary or calcareous chains, flow the fore-mentioned streams, formed partly by the superficial melting of the snow, and partly by filtration, or by the *springs* of the schistose strata.

When the two streams have met, they find a ready exit through a channel, which most evidently has not been worn away by water, for the strata are not disunited, but have subsided.

It is here judiciously remarked by our Alpine traveller, that vallies, crossing the measures of a country, are not always formed by erosion, but are frequently produced by the partial sinking of their strata, and thus it has happened in the case before us.*

From the mountain of St. Gothard, three vallies originate, as from the central point of Europe, and terminate—the first in the German sea, the second in the Mediterranean, and the third in the Adriatic. In these flow the Rhine, the Rhone, and the Po, which are so far from having excavated these extensive vallies and their attendant plains, that they never had existed had not disruption of the strata first contributed to form their beds. Rivers originate in springs, and springs, as we have seen, originate in the disruption of the strata through which the rain and dew have percolated. They are supplied by water from the clouds, and disruption of the containing strata gives them vent, an operation this, which did not require millions of ages to accomplish.

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* Saussure Voyages, § 960. 961.

If we consider what has been demonstrated, as to the range and dip, or inclination of the chalk in Hants, Sussex, Kent, Essex, Picardy, and Normandy; the English channel must be regarded as a deep valley, formed either by elevations or depressions, not by erosion, for the chalk bed is continuous; and I may add, that the chalk valley, thus formed, was evidently filled to the height of many hundred feet by alluvial strata, whilst it was yet under the waters of the ocean. This channel was not excavated by the Thames, the Rhine, the Seine, or by any other streams, for all these lend their assistance to fill up, and not to excavate the valley.

The same, as I apprehend, may be said of the continuation of this valley, if such it may be called, in the North Sea, at the mouth of the Elbe, of the vale itself, in which that river flows, and of the wide spread vale which gives vent to the waters of the Oder. For, taking the chalk hills as the margin of an extensive basin, inclosing channels, lakes, rivers, marshes, and alluvial districts, in Hants, Sussex, Kent, Essex, Cambridgeshire, Flanders, Lower Saxony, and Swedish Pomerania, we may look for the North Eastern margin of this basin in the Isle of Rugen, where, in the two promontories of Jasmund and Wittow, we see *chalk* cliffs, in the former two hundred, and in the latter three hundred and sixty feet high

In these cliffs many caverns gave shelter to pirates, till A. D. 1402, when they were destroyed, and since that time, by the mouldering of the cliffs, the caves have disappeared.

This margin appears again in Zeland and Mona, in which chalk cliffs have been observed.

It is therefore evident, that either the chalk hills have been elevated, or the chalk bottom has sunk, or it may be, that both these dislocations have taken place. Had the whole of this basin continued a sufficient length of time under the waters of the ocean, it would have been filled up, and would have become one most extensive plain; or, had the surrounding country been sufficiently elevated, we might have had a most extensive lake.

On a very contracted scale, we may contemplate a subsidence at Bradford, in Wilts. This town occupies a vale in which the Avon flows, being built partly in the bottom, and partly on the hanging of a hill, by which the vale is bounded to the North. Here we have evident marks of subsidence, for both to the North and to the South the cliffs of the great free-stone rock rise two or three hundred feet above the level of the river, which here runs on the back of the same rock. Of this we have sufficient demonstration, because we find the rock covered with the same bed of white clay in Burfield, immediately to the North of Bradford, in the bed of the Kennet and Avon canal, which is only thirty feet above the river, and on the summit of the Southern cliff. In all these places, so near together, and of such discordance in point of elevation, we discover precisely the same fossils and marine productions, peculiar to this bed of clay, particularly the pear encrinite, figured by Parkinson in the sixteenth plate of his second volume.

Many such vallies might be noticed, but this will sufficiently shew the nature of the operation.

The wide expanse, occupied by the City of Bath, is of a different nature; because the hills immediately to the North and South have the great free-stone and the bastard free-stone rocks, the latter of which is visible in Beechen Cliff and in Mount Beacon. But in the vale the river flows on the back not of these rocks but of the blue lyas, at a great depth beneath them; and wherever wells are sunk, the water issues on the blue marl, by which the lyas rock is covered.

Such vales as this, and such as the beautiful and extensive vale of Pewsey, in Wilts, were not produced by subsidence, nor yet by earthquakes and post diluvian convulsions, much less was the latter formed by the erosion of its gentle Avon. It must be confessed there have been attrition and erosion, but not the attrition and erosion of our feeble stream, which in no part of its course, and much less where it originates, could have moved our enormous bowlder-stones. This operation was effected at the bottom of the ocean, and in the bottom of the ocean such vales were formed.

OF THE CONSOLIDATION OF STRATA.

IN the green sand stratum of Pewsey Vale, the well-diggers find springs at various depths, but these always break out from under a hard sand rock, whose thickness bears proportion to the copiousness of the spring. These sand rocks appear to have been formed by *filtration*, because they are most consolidated in the middle, whilst the outer coat is loose and friable. It is precisely the same with the fossil corals, which are abundant in the green sand, for each coral is a nucleus, round which sand concretes. Many of these are themselves agatized, but are surrounded by loose sand stone.

With the corals we find numerous pectinites, whose edges are sharp and well defined. In these the shell itself is gone and the vacuity is occupied, or partly occupied, by silex. For in many, although the valves may seem to be perfect and entire, yet, when broken, they appear to have only a coating of flint, and to be hollow within. From this circumstance we may collect, that the silex was admitted in a state of *solution*, not of fusion, and was collected by the slow process of *filtration*.

In Trajan's bridge, over the Danube, below Belgrade, A. D. 1760, one of the timbers, under water, was found agatized to the depth of half an inch, whilst the centre was still wood.* And all the specimens of petrified, either bone or wood, I have met with, demonstrate, that the operation is slow and successive; for the medullary parts first decay, and being carried off leave vacuities, which are filled with adventitious matter, such as flint or lime-stone; then the fibrous parts submit to the same mutation. Were it otherwise the organic structure could not be preserved.

That the process of petrifaction in wood, is carried on by capillary attraction is evident, because we frequently observe, that tubes, made in it by the teredo navalis, remain hollow, whilst all the rest is solid. In many instances, whilst the petrified wood shews organic structure, the tubes are either filled with pyrites or coated with it. In some specimens from Walton in Essex, the tubes are wholly occupied by spar and preserve their form.

Mr. Parkinson, of Hoxton-square, has stems of trees impregnated, some with malachite, others with blue, green, and black calx of copper. These came from the Riphæan mountains. He has also been so fortunate as to collect some specimens of wood with pechstein, and agate interposed between the laminæ.

That changes of this kind are produced *by water*, is rendered still more evident by the lenticular crystals of quartz, found at Passy, and particularly noticed in my Spanish travels. For here the calcareous crystals have been carried off, and their places occupied wholly or in part by quartz, precisely as on Mendip, the dog tooth spar has vanished, and is replaced by calamine. Such mutations are extremely common.

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* v, Kirwan's Geol. Es. p. 140.

In the cabinet of Mr. Greenough I saw a group of quartz crystals, originally formed on a group of cubic fluor, which last being decomposed, left cavities. In these, new crystals are formed, some of Gallena, with fourteen sides, and some of Blend, which are tetraedral.—This curious specimen came from Alston Moor, in Cumberland.

Mr. Philips, a distinguished chemist in the Poultry, has, among his valuable fossils, cubic and octaedral quartz crystals, substituted in the place of disintigrated fluor, from near Paisley, in Scotland.

Mr. Parkinson has a beautiful cornu ammonis, with all its septa distinct, and its chambers occupied by a considerable number of perfect pellucid quartz crystals.

Dr. Parry, of Bath, in his cabinet of minerals and fossils, has a geode, or hollow nodule of onyx, lined with amethystine quartz crystals, and containing one large crystal of rhomboidal calcareous spar, which has taken the quartz crystals for its base. In this onyx all the coats run parallel, and conform to the inequalities of the cavity, which therefore must have been progressively occupied by these substances, not in a state of fusion, but conveyed by water, and collected by filtration.

In my own cabinet I have a geode from Wick, near Bath, hollow and lined with quartz, in which a beautiful crystal of calcareous spar stands erect, like a hermit in his cell.

In the deep mines of Cornwall I have collected crystals of quartz, double pointed, crossing each other in various directions, attached together, yet leaving considerable vacuities between them; and in one mine, worked by my father-in-law to a great depth for tin, I found a lode occupied by long quartz crystals interwoven, with vacuities between them, in which were crystals of blende. This lode carried so much water, that the adventurers abandoned it. In a neighbouring mine I picked up a very uncommon mass of mundic crystals, which are perfect parallelopipeds, crossing each other, with vacuities between them. In my cabinet, I have a most interesting specimen from a tin mine of my father's, at Cleggor, in the parish of Perran Zabulo, in Cornwall. It consists principally of white quartz, with wolfram interspersed, and has a little cavern enriched with beautiful crystals of quartz, to which are attached crystals of tin. One of these has a prism and two pyramids, and carries on its back other crystals, some of mispikel, and some of hexagonal mica. In the same aperture are six long crystals of wolfram, like needles, crossing it in various directions, and attached by their extremities from side to side.

Not far from this mine, in Cleggor Cliffs, I met with several tin lodes, of about one inch in thickness, divided each into two portions, separated by white clay, which was so impregnated by water as to resemble a liquid paste. I collected numerous specimens, and having washed them, was rejoiced to find in most of them two faces of beautiful tin crystals, which the intermediate clay had hid. In some, however, these faces had met together, the lode was solid, the crystalline forms had vanished, and nothing remained but a spathose appearance in the fractures.

The same circumstance may be remarked in camerated shells, such as nautili and ammonites, whose chambers are either partially occupied, or wholly filled with calcareous spar; and so likewise in the ludi helmontii, or turtle stones, which abound in beds of marl. Some of these, now before me, shew a separation in the middle of each septarium, without the least resemblance to injections, made by one homogeneous substance. Indeed it is evident, that the coloured matter was attracted in succession by the sides of these vacuities, through which it was equally diffused, and that after the first supply was exhausted, matter of a different colour flowed through the apertures to form new laminæ. The smaller veins were first filled; and, when progressively every avenue was closed, the larger veins had vacuities remaining, and in these the crystalline forms appear. Most of the smaller veins, when polished, shew the line of separation, but in some the union is so complete, that the line of separation is perfectly obliterated.

In Essex, the nautilus pompilius is sometimes found with its pearly shell, and in some instances has its beauty much improved by iridescent crystals of pyrites, diffused over the surface of its chambers. These therefore cannot have been subjected to the action of fire, but must have received their adventitious matter from water.

It is well known that madreporæ and all kinds of coral are extremely porous, and even when petrified, may remain the same.—Specimens of such I have collected from Calne and Midford; but in both these places, and indeed wherever coral beds appear, they have commonly their apertures closed by a paste of calcareous matter, and then become hard, ponderous, and susceptible of the finest polish. Here it is evident that consolidation has been performed by means of water, as the vehicle of lapidific matter, for the original habitation of the animal is still visible, though no sensible porosity remains, and this could not have been the case had the consolidation been produced by fire.

In the bastard free-stone stratum of Bath, we find numerous mytili, incrusted with a fine paste of calcareous matter. Between Stokebridge and Bradford, I picked up a large pectinite, whose valves were open, and contained, as I have stated, many small mytili, attached by a kind of cable to its ribs. All these, excepting one, had the forementioned coating, and some of them had, in addition to this, calcareous crystals. But the most beautiful specimen of this kind I ever met with, is in the cabinet of Thomas Mead, Esq. of Chatley House, near Bath. It is a mass of bastard free-stone, with a small cavity of about one inch by three, in which are regularly disposed twenty-two of these coated mytili, some of which shew their cables. The biggest of the muscles are seven-eights of an inch long, and the least are one half that length.

These specimens mark different epochs, and agree in proving, that the smooth coating was acquired under water.

In the present state of our knowledge, it is difficult on chemical principles to account for the consolidation of strata by those substances, which nature commonly employs, such as fluor, calcareous spar, and silex; because all these are at best imperfectly soluble in water. Yet, as they are subject to comminution by abrasion, we may readily conceive, that, when in a state of extreme tenuity, they are diffused in water; they may be obedient to a general law, and not only form a consolidating paste, or appear in stalactites and stalagmites, but also crystallize.

It has been remarked above, that contiguous strata are apt to mix and to change by insensible degrees. This would not have been possible had they been fused, but may be clearly understood, supposing the subsidence to have taken place in water.

Thus much may suffice at present to have advanced on the process of consolidation. This subject, however, will be resumed, when I shall proceed to special observations on a novel theory of the earth, and I trust it will then appear, that its inventor has been too hasty in some of his conclusions.

OPERATING CAUSES OF DISLOCATION.

FROM what has been stated, it is evident, that all the habitable parts of the earth were originally formed at the bottom of the sea. Of this truth no naturalist of the present day entertains a doubt

The only question therefore is, by the agency of what cause has the bed of the pristine ocean become the most elevated portion of our globe; or by what means has it been accomplished, that the strata, once horizontal, are now either vertical or much inclined to the horizon.

The most distinguished mineralogical writer of the present day is of opinion, that all inclined strata, with a very few exceptions, have been formed so originally, and do not owe their inclination to a subsequent change.

He conceives, that the ocean *formerly covered the whole earth at the same time*, and that in the earliest periods chemical productions only were formed, because when the earth was entirely covered to a great height with water, no mechanical deposits could be produced

In his opinion, the level of the water changed uniformly and universally, and the ocean sunk by degrees to its present level.—The consequence of this change has been, that as soon as part of the solid mass appeared above the water, mechanical deposits first began.

In confirmation of this hypothesis, he states that granite, gneiss, mica slate, the primitive rocks of clay slate, lime-stone, trap, serpentine, porphyry, and sienite, are chemical precipitates; that the first appearance of a mechanical deposit is in the rocks of transition, lime-stone, trap, and grauwacke, after which chemical precipitation nearly ceased, and the flœtz formation followed.

He states, that the transition lime-stone was composed of the most imperfect class of animals, encrinites, pentacrinites, madreporites, tubiporites, and trochites. And he very judiciously remarks, that in the succeeding formations first marine plants and animals make their appearance, that shells and fish succeed, after which come land plants, and last of all land animals.

In this enumeration and progression all geologists agree.

But according to this system, ought not the strata to resemble the coats of the onion; and should not the granitic nucleus be completely covered by the gneiss, and this again by mica slate, and so on to the latest deposite, extended over the surface of the globe? Thus certainly earlier deposits are in many places hid by the freestone and other calcareous beds, as these are by thick beds of chalk, with its superincumbent clay, sand, and gravel.

Dr. Jameson, who has brought forward this system in his valuable work on mineralogy, proposes a question, which he will not speedily resolve. He is solicitous to know what has become of the immense volume of water that once covered and stood so high over the whole earth? He proceeds—“Although we cannot give any *very* satisfactory “ answer to this question, it is evident that the *theory* of the diminution of the water remains equally *probable*. We may be fully convinced “ of its truth, and are so, although we may not be able to explain it. “ To know from observation that a great phœnomenon takes place, is “ a very different thing from ascertaining how it happened.”

The mountains of Tibet, he states to be twenty-five thousand feet above the level of the sea, and much more than this, according to the system now before us, must have been the height of the water over the surface of the globe.

To command assent, some answer should be given to the question he proposed; no one in the present day will have recourse to such an expedient as that with which Dr. Catcott was satisfied, when he supposed, that a solvent formerly existed, which dissolved all substances, except sea shells. He had ransacked the bowels of the earth; he had examined the organic remains of a former world; and he had found only the productions of the ocean. To him all land animals and plants had vanished; but by his solvent he got rid of all his difficulties.

In the present case some expedient should be devised for getting rid of this immense volume of water that once covered the present habitable portion of our globe, and then the hypothesis will be consistent in all its parts. But the difficulties still increase, for, after the general subsidence of the water which enveloped the globe, we find *new chemical* solutions, and new chemical precipitates.

According to Dr. Jameson, the newest flœtz-trap formation covers many very new flœtz formations, and also uncommonly high primitive mountains. It has but little continuity, being almost always broken, but is very widely distributed. The rocks belonging to it are green stone, grey stone, porphyry slate, and basalt; under these we find wacke, clay, sand, and gravel, and, accompanying the latter, there are great beds of bituminous fossils, which are partly in the state of coal, and partly ligneous. In the *lower* parts of this formation, therefore, we find *mechanical* deposits, composed of clay, sand, gravel, and heaps of trees; and these are so arranged, that the coarsest are undermost; *but above*, we have the finest mechanical, and the coarsest *chemical* depositions, as clay and wacke. Basalt, which is immediately over the wacke, is to be considered as a coarse *chemical* precipitate, having an earthy aspect and no lustre, and has probably been precipitated from an agitated solution.

Lastly, porphyry slate, grey stone, and green stone, are to be considered as precipitates from a state of complete chemical solution. They pass into each other; and green-stone, which is usually the uppermost, is the most crystalline. He proceeds—" It is evident, " from the nature and position of these rocks, that they have been " formed by a vast deluge. The water appears to have risen rapidly; " again to have become more calm; and, during the period of its

" settling, to have deposited the different rocks of this formation; and, " lastly, to have retired to its former level with considerable rapidity."

" During the *settling* of the water, as we have just mentioned, " the different rocks appear to have been formed, and the broken " stratification, which is so characteristic for this formation, partly " by the *rapid retiring* of the water. The heaps of trees, the beds of " gravel, sand, and clay, and their more frequent occurrence in low " than high situations, their constant occurrence in the lower parts " of the formation, are evident proofs of the rapid and tumultuous " rising of the water; the calmness of the water is proved by the " fineness of the mechanical, and the increasing fineness of the chemical solution, according as we approach to the newer members, or " upper part of the formation."

Here we find or seem to find, the immense volume of water again returned to cover the whole surface of the globe, and rising above the most elevated mountains. We see this formation "covering the " highest summits of the Saxon Erzgebirge, and forming the summit " of the peak of Teneriffe, elevated about eleven thousand and eighty " feet above the level of the sea."*

But neither here do our difficulties end; for this immense volume of water again "retires with considerable rapidity;" yet we are not informed whence it came, nor whither it retired.

Here then we may leave this system, and proceed in our examination of dislocations, and the operating causes by which they have been produced.

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* Dr. Jameson's Miner. Vol. III. p. 84, 85.

That the strata were once horizontal is evident, from their having been formed in the sea. In their dislocation we have two epochas, perfectly distinct, for the granite and the schist, with the mountain lime-stone, must have been the first displaced, after which horizontal strata were again deposited on them, and these, being now inclined to the horizon, must in their turn have been disturbed, for their dip, as I have already noticed, is in a direction opposite to that of the preceding strata.

Among the moderns, Lazzaro Moro and Dr. Hook were perhaps the first, who attributed these effects to fire; but the first who suggested the notion, that the earth had shifted her poles, was Mr. King, as appears in the Philosophical Transactions of 1767.

Indeed, long before the days of Lazzaro Moro, suspicions had been entertained of the agency of fire, in the elevation of our Continents, from beneath the waters of the ocean. Strabo imagined, that islands may have been raised by earthquakes, and says, if islands why not continents. He conceived that Sicily was not broken off from Italy, but raised from the fire of Ætna. Pliny likewise speaks of many islands appearing suddenly in the sea, such as Delos, Rhodes, Anaphe, Nea, Alone, Hiera, Thia and Thera.

But here it may be proper to inquire, is the cause assigned, adequate to the effect produced?

When we turn our attention towards *volcanic* fires; Ætna, Vesuvius and Mount Heckla, immediately occur to our recollection and we are ready to imagine, that our enumeration is complete. This however is far from being the case.

Ætna has been noticed from remote antiquity, and by authentic records it appears, that in twenty severe eruptions, it shook the whole of Europe. The first of these was five hundred years before the Christian Era. But prior to the most ancient records, excepting those which are left engraven on our mountains, eruptions, either from Ætna, or from some volcano, not far from it, took place in the bottom of the sea; for near Sortino, in Sicily, horizontal strata of lava alternate with beds of calcareous rock, which are full of madreporæ and shells. Sortino itself stands on the summit of a calcareous mountain, whose scarp, overhanging an extensive valley, is more than twelve hundred feet high. The mountain on which Carlentini stands, is half calcareous and half volcanic, with this remarkable circumstance, that these substances are separated by a vertical plane.* Ætna has raised, to the height of many miles, enormous rocks, such as must have been torn from caverns, far beneath the level of the sea, and has projected them to the distance of more than twenty leagues. I have never been in Sicily myself, but a valuable friend, now in high employment there, on whose accurate observation I can depend, is of opinion, after minute investigation, that Ætna was not produced by fire acting under an island already formed; but that the whole of the Phlegrœan territory, now covered by extinguished volcanoes, was forced up from below by subterranean fire, on a margin of the island were the least resistance was opposed to its explosion.

Vesuvius, if we may credit Dion Cassius, cast its cinders as far as Rome, and even into Egypt. This happened in the reign of Titus, when it overwhelmed the Cities of Herculaneum and Pompeii. One eruption sent forth a river of lava, wide, deep, and seven miles in length.

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* Journal de Physique, Sep. 1784.

In 1779, a volume of liquid fire rose ten thousand feet, almost perpendicular, and exhibited a flaming mass of nearly two miles and a half in breadth. This continued in full force more than half an hour, and the eruptions were repeated five times in as many days. The ashes were dispersed near one hundred miles, the shower of stones fell to the extent of thirty miles, and among them some measured from sixty-six to one hundred and eight feet in circumference. One was semivitrified, round and polished, and had on it considerable portions of coarse glass, like that of common bottles*

In 1795, the Archbishop of Tarento observed a thick cloud of volcanic ashes, which came two hundred and fifty miles from Vesuvius, and some fell in the Province of Lecce, at a still further distance.†

Between these volcanic mountains, we have numerous islands, in the bay of Naples, which occasionally send out flames

Stromboli, as appears by Strabo, was burning two hundred and ninety years before the birth of Christ. It rises a mile above the level of the sea, and it is said to be wholly composed of lava.

Another of these little islands, called *Vulcano*, attracted notice four hundred and seventy-five years before our era, and perfectly answers to its name. A third, no less worthy of attention, than the preceding, is *Lipari*, nineteen miles in circumference, and apparently composed of pumice-stones, which, from hence, are sent to every part of Europe as an article of commerce.

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* Sir William Hamilton's Phil. Trans. Vol. 70.

† Phil. Trans. 1795.

All these volcanoes have some communication established deeply in the bowels of the earth; and Naples itself stands upon a burning arch formed by Sulfaterra and Vesuvius.*

Heckla, the most considerable volcanic mountain in the North of Europe, rises nearly five thousand feet above the level of the sea. From A.D. 1000 to 1766, twenty-three eruptions have been noticed, and the last continued five months without intermission. Iceland is three hundred and sixty miles long, by two hundred and forty wide, and in its whole extent it has one chain of volcanic mountains, whose summits are covered with snow. The soil is decomposed lava, and hot springs break out at Laugarnes, at Geyser, and in various other places. They are indeed innumerable, dispersed over the whole country, and break out forty or fifty near together, some on the tops of mountains, others either in the vallies, or in the adjacent sea.

The principal spring, called Skalholt, has an aperture of nineteen feet diameter, with a basin of fifty-nine feet, out of which a stream arises, frequently every day by intervals to the height of ninety feet. This, even when descended, retains the heat of from 188 to 212 degrees of Fahrenheit's thermometer.†

In the year 1783, as we have been recently informed by Sir George Mackenzie, flames rose from the sea thirty miles off Cape Reikianes, and continued four months, during which time vast quantities of pumice and light slags were washed on shore. At the time when the flames ceased to issue from the waves, earthquakes were felt, and a dreadful eruption commenced from the Skaptaa Jokul, which is nearly two hundred miles distant from the spot, where the marine eruption took place.

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* Spallanzanii Two Scilies, 4. tom. 8.

† Horrebow's Iceland, and Von Troil's Letters on Iceland.

The mountains of *Lapland* seem to be indebted to volcanic eruption for their existence.*

In the *Ægean* sea we find numerous volcanic islands, Argontiera, Lemnos, Lesbos, Milo, Naxia, Polino, Santorin, and Tenedos. Both Nea Caimeni and Hiera had volcanoes, and Calamo has one still burning.†

Dr. Clarke has noticed in his map of the Crimea, numerous volcanoes on the opposite coasts of the Cimmerian Bosporus, which seem to merit particular attention.‡

In the island of *Taman*, there have been many volcanic eruptions of mud, attended by vapour, flames, and noise, with chalk, schist, and iron-stone. Similar eruptions have been observed at Makuba, in Sicily, and in the Peninsula of Baku, with inflammable vapour and springs of Petroleum.§

From Europe, if we proceed to Northern Asia, the same abundance of volcanic mountains will there attract our notice:

And first in the Uralic chain, between the Volga and the Oby, Professor Pallas saw a burning mountain, called *Kargonsch Kongisch*, and near the mouth of the Amour, M. la Perouse met with red lava and grey basalt.

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* Tooke's View of the Russ. Emp.

† Olivier's Ottoman Empire, 4to.

‡ Clarke's Russia, 4to. p. 680.

§ Pallas' S. Journey, vol. 2.

Kamtschatka, extending between 51° and 62' North latitude, is remarkably mountainous and barren. In this province the elevated chain stretching North and South, contains twenty volcanoes, of which the subsequent are particularly noticed.

1. Opalsk; 2. Viluitshiskoi; 3. Avatscha; 4. Tylbatchic; 5. Shevelutsh; and 6. Klutshefskoi; which last may be reckoned among the highest peaks in the world. M. la Perouse says, that one of these threw out clouds of smoke, with stones and ashes, A. D. 1778, and another in 1762. The whole country abounds with hot springs. Twenty miles to the South West of Cape Lopatka, our navigator passed a solitary mountain in the sea, whose summit was burning violently A. D. 1793.*

Japan consists of nothing but an assemblage of mountains, with their circumjacent vallies. Here we have a vast store-house of volcanic matter. Some of its most elevated peaks exhibit continual flames, and the neighbouring seas by night gleam with its numerous fires.†

To the South of Japan we have the *Ladrone*, or Marianne islands, one of which was pouring down torrents of lava when M. la Perouse passed by.

The *Philippine* islands have numerous volcanoes, and they are no less abundant in the *Moluccas*.

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* Sauer's Account of Billing's Voyage, 4to. 1802, and Benyousky's Kamtschat, 4to. vol. 1, p.1 56.

† Maurice Ind. Hist. vol. I.

Sumatra, as Mr. Marsden informs us in his excellent work upon that island, has many volcanic mountains. One now burning rises twelve thousand four hundred and sixty-five feet.

Java has three mountains, Cheribon, Tagal, and Paranucan, with each a volcano on its summit, which frequently pour forth their lava on the subjacent plains; and hot springs perpetually rise in a valley shut in between two extensive ridges of the Chipannas mountains.*

In the year 1693, half the island of Sorca, one of the *Moluccas*, was swallowed up, and a burning mountain sunk into a fiery lake.

Celebes, *Chiaus*, and *Amboyna*, have their volcanoes. Near Timor, Dampier saw two islands with burning mountains; and Clavigero makes mention of a volcano in the island of Ternate, equal in magnitude to Ætna.†

In the *Banda* islands the same phœnomena may be observed; and among these the most remarkable is Canapis.

The *Andaman* islands occupy the East side of the Bay of Bengal; and fifteen leagues Eastward of these is a barren island, with a volcanic mountain rising one thousand eight hundred feet. Near the shore, ships find no soundings with a line of one hundred and fifty fathom.‡

Ceylon has its volcanic mountain, called Adam's Peak.§

Of the *Malabar coast* we have no account, but I doubt not that were it explored, volcanoes, or their remains, would be abundantly discovered.

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* Thunberg's Travels, vol. 4.

† Clavigero's Mexico, by Cullen.

‡ Asiatic Researches, vol. 4, p. 413.

§ Maurice Ind. Hist.

At the mouth of the *Red Sea*, Bruce met with two volcanic islands, the one called Foosht, the other Gibbel Teir, both covered with pumice-stones, and the latter sending out clouds of smoke.

The *Isle of Bourbon*, East of Madagascar, is circular, and fifty leagues in circumference. In the centre of this island, is a mountain nine thousand six hundred feet above the level of the sea, always burning, and frequently sending forth eruptions.*

To the South East of Bourbon, in the Indian Ocean, is the *Isle of Amsterdam*, in which is a volcanic mountain three miles in ascent. This, when Lord M'Cartney was sailing by in the year 1793, sent out flames from six different craters, at a considerable distance from each other.†

At the *Cape of Good Hope* the table mountain, which is three thousand three hundred and fifty-three feet high, has for its covering sand-stone and lava. The middle is trap, with fragments of quartz, and the bottom is slate. Near all the mountains of Southern Africa are numerous springs, of a boiling heat.‡

In the Atlantic Ocean, the island of *St. Helena* is known to be volcanic. The hills in this island, near the sea, rise to the height of one thousand four hundred feet; but inland they are two thousand six hundred and ninety-two feet. These are covered by lava and pumice-stones. The strata consist of basalt, alternating with beds of volcanic matters and thin layers of variously coloured clay. They are very oblique, and terminate both above and below in such a manner, that it is impossible to discern where the rock ends, and the clay begins. The clay itself, like the basalt, is columnar, and is abundant in cavities like the common whin-stone. In the heart of the rock we find nodules of clay, and in the heart of the clay we have nodules of rock. The interior hills are mostly clay, with some beds of basalt, and with ponderous lava, resembling iron recently fused, dispersed among it.

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* Rochon's Madagascar, 8vo. 1792.

† Anderson's China, p. 44.

‡ Thunberg's Travels, I. 161, 224.

All these hills are penetrated from top to bottom by strata of rock, which are shivered, but whose fragments are contiguous, and separated only by smooth surfaces. These strata rise perfectly bare to a stupendous height above the summits of the hills. Near to the shore the soundings deepen suddenly from fifteen to one hundred fathom.

The *Island of Ascension* perfectly resembles this, and so do some of the Cape de Verde Islands. Among these, *Fuego* sends out great rocks, with pumice-stones and much sulphur. The *Canaries* are equally productive in these substances, and the peak of *Teneriffe*, rising more than twelve thousand feet above the level of the sea, emits volumes of smoke, with lava. In the year 1704, whole towns were either swallowed up or destroyed by its devouring flames. This elevated peak is surrounded by mountains half as high as itself, composed of lava.

Its more humble companion in the island of *Palma* had eruptions A. D. 1652; and, West of this, *Hiero* broke out A. D. 1692, at the time when Kingston, in Jamaica, was destroyed.*

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* Astley's Voyages and Adanson's Voyage to Senegal.

The *Azores*, or Western islands, are no less remarkable than the preceding for subterranean fire. In this Archipelago stands *Fayal,* whose volcanic mountain, in its centre, sent forth torrents of lava in the year 1672.*

The *Caribbee* islands seem to be spiracula of a great reservoir of fire. Among these we reckon the subsequent.

Trinidada, the largest island of the Caribbean Archipelago, and surrounded by rocky islets, is free from hurricanes. When we consider, says Dr. Chisholm, its high granitic and argillaceous mountains, which constitute a strong barrier against the encroachments of the ocean on the one side, and the gradual declivity or perfect level of its surface on the other; when we compare this formation with the circular and extensive gulph which it shuts in towards the East,—the bituminous lakes and exudations—the spiracles of moffete, and the sulphureous springs, which characterize a large portion of its lee shores; and when we perceive that a similar construction obtains on the main land, inclosing the remainder of the gulph; we hesitate not in referring these peculiarities to a volcanic origin.†

Granada, being one of the most Southern of the Caribbean islands, is exempted from the dreadful hurricanes of the Northern range. It is composed of two vast mountains, which terminate in peaks, but, being united a little below their summits, their division is not at first sight perceptible. The descent is gradual on the North East side. The South West limits are bold and precipitous, and have numerous conical hills, with high cliffs of the madrepore coralline, the cells of which, nearest the sea, and occasionally overflowed by it, are inhabited by zoophytes, lithophytes, and animals of the Mollusca tribe.

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* Adanson's Senegal.

† Dr. Chisholm on the Malignant Fever of the W. I. p. 222.

The coast is defended from the encroachments of the ocean by this prodigious barrier of corallines.

To the South-east, even at the depth of fifteen fathom under the surface of the sea, groves of pink coloured corallines are visible, with vast numbers of echini, asterias, sponges and univalve shells.

From the South-west to the North-east, along the Western shore, no corallines are ever seen; but the shores, where shelving, are covered with stones of quartz and of shörl, either thrown up by the sea, or produced by its encroachments on the high and rocky cliffs.

On two parts of this coast, basaltic columns, there called organs, are most abundant.

The morne rouge, or red mountain, is composed of three conical hills, of five or six hundred feet perpendicular. These have vitrified rocks and scoriæ, with earth resembling rust of iron, and appear to have formed the crater of an immense volcano. Indeed many lakes perfectly circular on the summits of the highest mountains, seem to have been craters.

Barbadoes is celebrated for its petroleum, known commonly by the name of Barbadoes tar. In the same district with it are chalybeate and sulphureous springs, and many fissures, from which much inflammable air escapes.

St. Vincent and St. Lucia are true volcanic islands, with numerous groups of conical hills. In the former we have morne garou, rising five thousand and fifty feet above the level of the sea.

Martinico is distinguished by its volcano on Mont Pelée, round which is much pumice-stone. The rock is granite covered by argillaceous schist.

Dominica is a confused mass of enormous mountains, of which the highest, supported by others less elevated, rises six thousand feet above the level of the sea.

Here the influence of volcanic fire is obvious, more especially where the solfateras exhibit unequivocal traces of it. Of these the mountain called Soufriere, though not the largest, is the best known.

The basis of this island is granite covered by argillaceous schist.

Antigua is argillaceous schist rising one thousand three hundred feet above the level of the sea. It has few springs, and no traces of eruptions.

St. Christophers, among its rugged mountains, has one called Mount Misery, rising three thousand seven hundred and eleven feet above the level of the sea. It is granitic and has a perfect crater. To leeward it has elevated mountains and steep rocks. Brimstone Hill, at the foot of Mount Misery, is truncated and is undoubtedly volcanic. It was formerly much troubled with earthquakes; but since the eruption of its volcano these have ceased.*

Montserrat and *Guadaloupe*, after long intervals, have exhibited eruptions.

Tortola exhibits tokens of dislocation, such as have not been noticed in the circumjacent islands. It does not appear that either sulphur, hot springs, or other indubitable tokens of volcanic fire have been discovered in it. But in the Peninsula, called broken Jerusalem, granite blocks of two hundred feet in circumference, are scattered over an argillaceous surface of six miles square.

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* Phil. Transactions and Edwards's Hist. of Jamaica.

St. Croix has central hills rising one thousand feet above the level of the sea. To the West of these the surface is level, and the rock is calcareous with chamæ, and pectines in great abundance.

To the East are numerous conical hills of argillaceous schist, and it has been imagined, that the whole island must have been raised by a submarine volcano.

Nevis has certainly been produced by an eruption. It has a crater, numerous hot springs, and abundance of sulphur.

The other islands, to the South and to the West of these, have not been sufficiently explored, but the whole chain of the West Indian Islands is said to be volcanic, and the frequent earthquakes, to which they are exposed, tend to confirm this opinion.

For the whole of this accurate information, respecting these islands, we are indebted to Dr. Chisholm.

In South America, Terra del Fuego, (the land of fire) speaks for itself.

In *Chili*, the cordilleras exhibit fourteen volcanoes, now burning, and more than as many which emit smoke and produce much sulphur. Beside these, West of the Andes are two others, one of which, near Villarica, may be seen at the distance of one hundred and fifty miles, constantly burning. The top of this mountain is covered with eternal snow. The Lake of Villarica is seventy-two miles in circumference, and has a conical island in the centre. In the great eruption of

1760, Peteroa filled the circumjacent vallies with lava, and one mountain was rent for many miles in extent. Pumice-stone is so abundant in the Andes, that it forms the substance of several mountains.

The islands in the Archipelago of *Chiloe* are four-score, all which shew marks of fire, and the greatest of them has basaltic columns.*

On the coast opposite to the Island of Chiloe, is a volcano, subject to violent eruptions, and the sea is so deep that ships cannot anchor, for, even in the port of Valparaiso, close in land, they have ten fathom water, and therefore to moor their ships they are obliged to have three anchors on shore. Descabezado, one of the most lofty mountains of the Andes, has a deep lake on the summit, which Molina conceives to have been a crater.

In Conception Bay are to be seen traces of a city, swallowed up A. D. 1751.

Peru, like Chili, stretches North and South, and is inclosed between the cordilleras of the Andes and the Pacific Ocean. The land on the coast is of stupendous height, with four ridges parrallel to the shore, rising in succession as you advance towards the East. It has few rivers, some of them are one hundred and seventy miles apart, all very shallow, and most of them often dry.†

It must be here remarked, that the principal rivers run Eastward, and empty themselves into the Atlantic Ocean, for in that direction all the great springs break out, consequently in that direction the strata dip. To the West the coast is bold, and the sea extremely deep; to the East the sea shore is flat and water shallow. To these observations I must add, that the mountains of the Andes abound with subterranean fire, of which on the Eastern coast we have no vestige.

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* Molina's Chili, 2d vol. 8vo.

† Dampier's Voyages.

The district of Lima, as we shall more particularly notice, has suffered exceedingly by earthquakes, and these we know are dependent on volcanoes. When the fort of Callao was overwhelmed, the same night, 28th October, 1746, a volcano broke out at Lucanias; and three others, in the mountains of Patas, discharged such torrents of water, that the whole country was overflowed.*

Quito has not been more fortunate than Lima. In its vicinity we find the same destructive element, for Pichincha, rising fifteen thousand nine hundred and forty feet above the level of the sea, has its volcano, which covered Quito with its ashes, obscured the sky for three days successively, and caused the destruction of thirty-five thousand people in that province.

Cotopaxi, rising three thousand one hundred and twenty-six toises, or nineteen thousand three hundred feet, that is more than three geographical miles, above the level of the sea, has a volcano on its summit. This broke out A. D. 1533, and renewed its ravages in 1743. It has been heard at the distance of one hundred and twenty miles.

Between Cotopaxi and the Southern Ocean, Humboldt reckons forty volcanoes constantly burning.

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* Ulloa's America.

In the Andes we find *Antisana*, whose height is nineteen thousand three hundred feet, and in which the grand eruption of 1590, has been particularly noticed.

About the same time *Aconcagua*, rising fifteen thousand six hundred feet poured forth its lava.

Cayambé Ourcon is nineteen thousand three hundred and ninety-two feet high, and is a volcano, but the period of its eruption has escaped observation.

Cargavirazo was burning furiously in 1698, and has been measured. It is fifteen thousand six hundred and eighty feet high.

Sinchoulagoa broke out at the same time with *Pichincha*, A. D. 1660. It rises sixteen thousand four hundred and fifty-six feet.

Besides these many others have been transiently mentioned by our voyagers, but neither their height nor the time of their eruption has been specified.

Humboldt, near Popayan, visited one *volcano* at Pasto, and another on Purace, which throw out water. He is of opinion, that the whole Province of Quito is only one volcanic mountain, whose craters appear in the lesser mountains of Cotopaxi and Pichincha and communicate in the depth beneath.

At *Pichincha*, lying prostrate on a flat rock, which hung over the mouth of the volcano, he looked down into the throat, which is about one league in circumference. In this he took notice of many mountains, whose summits appeared to be three hundred toises beneath him, and he conceived, that the bottom of the crater might be on the same level with Quito. He smelt sulphuric vapor, saw blue flames, and almost every minute felt the tremor of the stone, on which he lay. The most Southerly mountain of this chain, rising seventeen thousand one hundred and fifty two feet, is *Sanguay*. This likewise has a volcano on its elevated peak, the noise of which is heard at Quito, at the distance of more than forty leagues, and which has been constantly burning since 1728.

Chimborazo rises twenty-one thousand four hundred and forty feet over a great gulf of fire.

Carguairaso, a little to the North of Chimborazo, proved itself to be volcanic about the same time with *Cotopaxi*. It is fifteen thousand six hundred and eighty feet above the level of the sea.

On Mount *Tunguragua*, rising sixteen thousand seven hundred and sixty feet, no fire appears at present; but, as it is perfectly conical in the midst of an extensive plain, in which are numerous springs equal in heat to those of Heckla, and is said to have been burning in 1641; there can be little doubt respecting its origin. *It has sunk* six hundred feet since it was measured by Condamine.

Mexico abounds with vulcanoes, and these, most fortunately for science, have been noticed by the most attentive navigator of our nation. Among them he reckoned, 1. Colima, with its two peaks constantly emitting either flames or smoke. 2. Attitlan. 3. Sapotitlan. 4. Sacatapeque. 5. Soconusco. 6. Amilpas. 7. Guatimala, with its two craters, one discharging fire the other water. The eruptions are chiefly in the rainy season, and have been so violent as to have twice destroyed the city. 8. Isalco. 9. St. Salvadore. 10. Sacatalepa. 11. St.

Michael. 12. Viejo. The mountain, from whose top this rages, resembles a sugar loaf, and being one of the highest in Mexico, may be distinctly seen at the distance of twenty leagues, emitting fire by night and smoke by day. 13. Teleca. 14. Leon Momotombo. 15. Granada. 16. Bombacho, with its three peaks. 17. Ariquipa, the highest mountain in the Mexican dominions.*

Besides these, noticed by Dampier, Clavigero makes mention of five others. According to him,

1. Pojauhtecatl, the highest mountain of Anahuac, broke out A. D. 1545, and is visible at the distance of more than fifty leagues.

2. Popocatepec, whose crater is more than one mile in diameter, rises thirteen thousand two hundred and twenty feet above the level of the sea. 3. Iztaccihuatl. 4. Tochtlan. 5. Juruyo, has three high peaks, and casts its ashes to the distance of a hundred and fifty miles. Such is the statement of this enlightened Mexican. But our more enlightened traveller Humboldt, in his Political Essay on New Spain, gives us a more distinct account of its five principal volcanoes now burning, and it is highly worthy of our notice, that all of them are found nearly in the same parallel of latitude. Stretching from West to East, they extend from Colima to Orizaba, from the Pacific Ocean, to the Gulph of Mexico. These rise highest towards the East, and the chain seems to have originated far from land, in clusters of islands, covered with pumice-stones, in the Pacific Ocean.

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* Dampier's Voyages.

From this circumstance Humboldt conjectures, that there exists a chasm, running East and West, for the length of one hundred and thirty-seven leagues. In confirmation of his opinion we may observe, that North of this range hot springs abound, and that from 18° to 22° there is nothing but basalt, amygdaloide and porphyry.

Of these volcanoes, Jorullo or Xorullo, pronounced Horuyo, demands particular attention. It first appeared in 1759, and at the same time thousands of volcanic cones were thrown up, from which issued subterranean noises. In the midst of these, six large masses rose one thousand six hundred and forty feet, out of the chasm, extending from N. N. E. to S. S. W.

Popocatepetl, the most elevated of the volcanoes, measures two thousand four hundred and fifty-five toises, and Caffre de Perote, the least elevated, rises two thousand and eighty-nine toises. Near Vera Cruz another volcano, called Tuxtla, made its appearance in 1793, and threw its ashes to the distance of fifty-seven leagues.

Nicaragua, which rises fourteen thousand three hundred and seventy feet above the level of the sea, is continually burning.

Higher up the Coast to the North, in latitude 55° near Port Bucgycarelli, La Perouse took notice of volcanoes, as did Captain Cook. Humboldt observed seven of them surrounding this port, and Vancouver, near the inlet which bears the name of the former, in 60° North latitude, saw several others.

The high mountains which defend this coast, are all granitic, and have immense glaciers, so steep, that after the first three hundred toises the wild goats cannot climb them, and the adjoining sea is so profound, that within a cable's length of the shore the soundings are one hundred and sixty fathoms.

The *Aleutan* Islands exhibit the same appearances. According to Benjowsky they are twelve in number, and of these seven are decidedly volcanic. One of them has no soundings, with a hundred fathom of line close in land, and all of the seven have occasional eruptions.*

Among the Sandwich islands is *Owhyhee*, whose most lofty peak is more than sixteen thousand feet above the level of the sea, whilst at the distance of two cables length from the shore, no soundings are to be had with a line of an hundred and sixty fathom. It is said to be formed of lava, and has a volcano on its summit.†

Toofoa, one of the society islands, has a volcano always burning.‡

Easter Island, in 27° 11′ South Lat. shews by its lava, to what agent it has been indebted for its existence.§

The *Navigators Islands* are ten in number, all volcanic, as appears by their basalt and lava.

Norfolk Island, about seven leagues in circumference, has a volcano, now extinct. The soil is covered with pumice-stones, and the whole island is surrounded with a wall of lava.‖

Near the Northern Hebrides, is the island of *Tanna* with its volcano.

On the Coast of New Guinea, Dampier discovered five islands, with volcanic mountains emitting flames and lava, and, as he approached them, he had no soundings. One such island is noticed near the Coast of N. Britain by Labillardiere and many more, no doubt, may have escaped observation.

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* Sauer's Account of Billing's Voyage.

† Cook's third voyage.

§ Cook as before.

‡ La Perouse, tom. II.

‖ See La Perouse and Philip's Voyage to Botany Bay, 4° 1789.

We have here taken a survey of a powerful agent, existing from the most remote antiquity in every quarter of the globe. Let us now examine its effects.

That EARTHQUAKES are related to volcanoes, as an effect to its proper cause, needs no proof: the connexion is palpable, and has been universally allowed. Historians, in all ages, have been careful to record the times and places in which they have been felt, and the ravages produced by them.

Strabo relates, from Posidonius, that two-thirds of Sidon, and a city near to it, were swallowed up by an earthquake, which extended over the whole of Syria. Dion Cassius mentions a similar event at Antioch, and Kircher informs us, that A. D. 1638, the City of *St. Euphamia*, in Calabria, sunk into the earth, leaving nothing, where it stood, but an extensive lake. Every one remembers the fate of Port Royal in *Jamaica*, almost buried by the sinking of the earth, and the eruption of the sea. At that awful moment numbers were swallowed up, and afterwards cast out into the harbour. Among these was a Mr. Campbell, father to a most intimate friend of mine, who was writing in his counting-house, and being afterwards perceived floating on the water, was preserved by the strenuous efforts of a faithful slave. It was even related, that where the wharf stood, there is now eight fathom of water, and that one plantation was removed half a a mile from the place where it stood before.

Clavigero informs us, that the earthquake felt in Canada, A. D. 1663, overwhelmed a chain of mountains, more than three hundred miles long, and left a perfect plain.*

The lower part of Peru is almost constantly convulsed, and during the earthquake, which, A. D. 1687, destroyed *Lima*, the sea retired, and immediately returned with such fury upon *Callao*, as to overwhelm the City. The same tragic scene was again exhibited at the distance of about three score years, for on the 28th of October, A. D. 1746, the concussions were so violent and reiterated with such rapidity, that in little more than three minutes *Lima* was again destroyed. Four hundred and fifty shocks were counted, during which the agitated sea retired, as before, to a great distance, but suddenly returned in mountain waves, destroyed the Fort of Callao, sunk nineteen ships, and carried four up the country. Of four thousand inhabitants three thousand eight hundred perished. These convulsions ceased on the bursting forth of a volcano at Lucanias.†

On the Coast of Chili earthquakes happen three or four times every year, and during one of these the City of Conception was swallowed up.‡

In the year 1755, when the great earthquake happened, by which every part of Europe and all the North of Africa were shaken, and *Lisbon* was destroyed, Loch Lomond in Scotland, was observed to be in a state of uncommon agitation, without any apparent cause. In Loch Tay such a phænomenon is not unusual, when every thing around is calm. The same frequently occurs in the Lake of Geneva, which suddenly ebbs and flows, when there is not a breath of air to agitate its surface. The cause, therefore, must be internal, and may be sought for in the agency of subterranean fire.

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* Clavigero's Mexico II, 221.

† Ulloa's America.

‡ La Perouse's Voyage and Molini's Chili.

Formosa, in the Pacific Ocean, is divided into distinct portions by a chain of mountains running North and South, and has fertile plains watered by numerous rivulets.

In the year 1782, May 22d a furious wind, with *heavy rain* and a *swell of the sea*, greater than was ever remembered, kept the inhabitants in continual apprehension of being swallowed up by the waves, or buried in the bowels of the earth.

Numerous public and private buildings were destroyed; and of twenty-seven ships of war in the harbour twelve disappeared, two were dashed to pieces, and ten were shattered. One hundred vessels shared the same fate, four-score were swallowed up and five were sunk.— Twelve other large vessels, which had not entered the harbour, were likewise swallowed up, with numerous barks of different sizes, and the whole island was covered with water.

The missionary who sent this account, adds—" It is evident, that " this disaster happened in consequence of an earthquake; and the " volcano which occasioned it, must have been at a prodigious depth " in the sea, as in similar events at Lima and at Lisbon."*

The volcanic islands I have mentioned, are not all of the same antiquity. The origin of many has been either within the memory of man, or at least within the reach of faithful records, and the late appearance of others may be proved by induction. Thus for instance on the coast of New Holland, the highest hills have coral in its recent state. One spot has been particularly noticed: It is an area of about eight acres, on the summit of a hill called Bald-Head, in which the sand produces no kind of herbage, but instead of vegetables are seen the branches of coral, rising near four feet above the sand, precisely as in their proper beds, beneath the surface of the sea. This, however, is not a solitary instance, for many such are found with numerous shells, some nearly in a perfect state, others in different stages of decay. In the plain, our navigator observed much petunse. The rocks are slate, sand-stone, and granite.*

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* Grossier's China, vol. 1, p. 222.

The reader will here recollect the facts I have adduced respecting HOT SPRINGS. These, from their vicinity to granite, and consequently to the volcanic regions, naturally suggest the notion, that they are indebted for their heat to subterranean fire.

In the same vicinity we frequently find *lava*, *pumice-stone*, and *basalt*.

BASALT has been noticed, as I have said, in the county of Antrim, and in a line from Staffa, through the whole extent of country between Dunbarton and Dunbar.

It is found in all the stratified mountains of West Gothland, like as in the Giant's Causeway, recumbent on a calcareous bed, which is rich in marine productions, and which, with the intervention of an arenaceous stratum, is itself recumbent on the great mass of granite.

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* Vancouver's Voyage, vol. I. p. 49, 50.

M. de Luc, the greatest experimentalist, and the most unwearied traveller of any age or nation, with more than common assiduity, explored vestiges of volcanic eruption, with lava, *basalt*, pumice-stone, and craters, on the borders of the Rhine, near Coblentz, over the whole extent of country watered by the Maine and the Moselle, and from Francfort to Cassel and Gottingen.

He particularly notices *lava*, near Francfort, covering a bed of calcareous sand, in which were Buccini, and covered by a calcareous rock, in which Dr. Miller found grinders of the hippopotamus. Not far from this he met with *basalt*.*

At Vivarais in Auvergne, and East of the Rhone, at Beaulieu, near Aix, *lava* and *basalt* are found incumbent on granite.

Mr. Petty, a very ingenious gentleman, on whose knowledge and accuracy I can confide, assured me, that he met with *basalt*, not only in the Carpathian Alps, which form the Southern boundaries of Poland, but in the chain of mountains which separates between Hungary and Transylvania. It is here remarkable that the *basalt*, as elsewhere, borders on granite, coal, and mountain lime-stone. To support the authority of Mr. Petty it may be observed, that Dr. Townson found *basalt* near Tokay, at the conflux of the Teisse and Bodroch, which is to the South of the Carpathian chain.†

The Cyanean Islands, in the Black Sea, at the mouth of the canal of Constantinople, exhibit a very interesting species of pudding rock, composed of lava, *basalt*, and marble, in whose fissures are found agate, chalcedony, and quartz. In the Strait are *basaltic columns* and bowlder-stones, which appear to have undergone first, violent action by fire, then long-continued friction in water.

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* Histoire de la Terre, tom. 4.

† See his Travels.

Many of these have been deposited on the *basaltic* cliffs, even to their summits.

On the North side of the Port of Ineada, near the entrance of the canal, the vertical fissures, between all the basaltic columns, are filled by a kind of white marble.

The Asiatic side of the Strait, has appearances similar to those above described, with this difference, that, oposite to its island, a little to the East of the Anatolian light-house, a range of *basaltic columns* may be discerned, standing upon a base inclined towards the sea; and, when examined with a telescope, exhibiting regular prismatic forms.

From the consideration of these circumstances and comparing events recorded in history, with the phænomena of nature, Dr. Clarke conceives it probable, that the bursting of the thrucian bosporus, the deluge mentioned by Diodorus Siculus, and the draining of the waters which once united the Black Sea to the Caspian, and covered the great oriental Plain of Tartary, were all the consequence of earthquakes caused by subterranean fires, described as still burning at the time of the passage of the Argonauts.*

Proceeding Eastward we have the Caucasian Mountains, between the Black Sea and the Caspian. In these Plescheef particularly noticed in succession granite, slate, lime-stone and basalt.†

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* Clarke's Russia, p. 666—680.

† Pleschef's Survey of the Russian Empire.

Beyond this, in the utmost extremity of Asia, La Perouse met with red *lava* and grey *basalt*, laid bare by the River Amour. Humboldt observed basalt on Pinchincha, elevated fifteen thousand five hundred feet above the level of the sea.

Indeed there is scarcely any part of the world, in which *basalt* has not been traced in the vicinity of coal, lime-stone, slate and granite.

I no where happened to observe *basalt* in Spain. In Portugal it is seen at Cape St. Vincent and near Lisbon. In Italy Albert Fortis traced its wide extent in the Venetian territory, round Verona, near Vicenza, and through the Tirolian Alps. He detected *lava*, where it had been unobserved before, and has favoured us with numerous interesting views of *basaltic columns*, scattered over the lime-stone mountains, which border on the Alps. His observations have been confirmed by Mr. Strange.

On the borders of the Veronese, fifty miles from the sea of Venice, is Mount Bolca, famous for its petrifactions, among which are enumerated more than one hundred species of fish, natives of Europe, Asia, Africa, and America, here assembled in one place. These are preserved in detached masses of calcareous schist, which lay in different directions, bedded in clay, and in the same mountain are *basaltic columns*. The fish must therefore have been caught by some volcanic eruption of slacked lime, derived from a calcareous rock, and being deposited in the sea, must have subsided horizontally. After its formation the rock must have been rent, and vast fragments must have been disseminated in argil, subsequent to which this mountain, with its companions, must have been elevated out of the surrounding waters.*

Dr. Jameson considers *basalt* as belonging to the newest flœtz formation, which covers both many very new flœtz formations, and also uncommonly high primitive mountains, rising four thousand feet above the level of the sea. That is the same bed, which at a lower level in Essex, Picardy, and the country round Paris, covers the bed of chalk, and contains shells and other marine productions, with the remains of terrestial animals.†

Now considering that by the statement of this distinguished mineralogist, veins of basalt traverse granite, gneiss, micaceous schist, mountain lime-stone, coal, and most of the flœtz rocks, and contain rolled pieces of quartz, gneiss, hornblende, and other fossils, I am inclined to class this rock, not only with *amygdaloide* and *pumice-stone*, but with *lava*.‡

It has been frequently remarked, that no volcano has been discovered on the Alps of Switzerland and Savoy. But the inferior Alps, the mountains of Verlaldo, Berico, and Brendola, those of Southern Tyrol, and the Euganean hills abound with *basalt*, and Mr. Strange rode from Montebello to Bolca, twenty miles, on *lava*.

In this volcanic district, all the coal beds lie on lava, and in many places they have taken basaltic columns for their roof. In the

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* Faujas de St. Fond Monte Bolca.

† Vol. III. p. 83.

‡ See Dr. Jameson, vol. III. p. 185—188.

Vicentin, they often meet with a vein of compact lava, between two beds of calcareous rocks, which are distorted by the lava, and have their crevices filled with it.

Dr. Festari, a friend of Albert Fortis, travelled on foot over the highest portion of the Venetian Alps, and from Valdagno he proceeded Northward by the Agno. In this route he discovered a most elegant breccia, composed of fragments of white marble in black *lava.* And Albert Fortis himself, in one of the Euganean mountains, observed many vertical beds, in which alternations of silicious breccia, with tuf, containing incoherent gravel, prove that these beds were once horizontal, and as with these was seen porphyritic lava, he was satisfied that these substances must have been ejected by a submarine volcano. On the whole, after the most diligent researches, he abandoned his pre-conceived opinion of the posteriority of volcanoes to the calcareous beds in the Tyrolean Alps, and was convinced, that the volcanisation of all that constitutes the mountainous districts of the Vicentin, Veronian, and Euganean mountains, has either preceded or alternated with the marine deposits.

The opinion of our countryman, Mr. Strange, nearly coincides with this. For, speaking of the Euganean mountains, which rest on a perfect plain, he remarks, that of these, the highest, Mount Venda, rising about one thousand six hundred feet above the level of the sea, is covered by slaty and calcareous strata, of posterior origin.†

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* Oryctographie de l'Italie, par Albert Fortis, 2 tom. 8vo. 1802.

† Phil. Trans. vol. 65.

Under basalt, clay is reported by Whitehurst to have been converted into brick; silicious sand is said to have become a perfect jasper; and we are assured, that coal has been charred.

It is particularly stated, that the last-mentioned fact has been observed and recently verified at Tividale, near Dudley, under a basaltic bed of thirty-five feet in thickness.

At Salt Coats, in Ayrshire, the whin dykes not only, as we are told, char the coal, but make it columnar.

Having thus cleared my way, I may proceed to state, that the whole Western coast of America, from Terra del Fuejo to the Northern extremity of Mexico, is indebted for its present relative elevation to the agency of fire, may be conjectured on the subsequent grounds. 1. The Andes, in their whole extent from North to South, shew the presence of volcanoes, and appear to be the great storehouse of subterranean fire. 2. They are extremely elevated above the surface of the sea, and the adjacent ocean is extremely deep. 3. They are evidently dislocated, and exceedingly abrupt. 4. The strata, once horizontal, now dip from the Andes Eastward, into the Atlantic Ocean, and on the Eastern coast the water deepens slowly, that is, about one fathom in a mile, as appears by sounding.

Now as fire, an agent of unlimited power, is visibly at hand in the very spot where a great effect has been produced, and as no other agent adequate to such an effect appears—may we not be permitted to conjecture, that volcanic fire has been the cause of this elevation? If so, then Strabo will appear to have been right in his conjecture respecting the production of islands, and warranted in his conclusion—*if Islands, why not Continents?*—Dislocation every where appears, and the powerful agent in question has every where been traced.

That subterranean fire has been the most prevailing cause of dislocation is now almost universally agreed. But here it must be confessed, that whether the effect has been produced by elevation, or by subsidence, is still undetermined. It is, however, to be hoped, that the sagacity, indefatigable industry, and accurate observations of our geologists will, by their united efforts, put this question beyond the possibility of doubt.

A different species of dislocation, wholly unconnected with the preceding, has been noticed on the Northern extremity of Lansdown and at Derry Hill. Such dislocations are extremely common. To understand their nature, we must call to mind, what has been said of strata, and of springs, and must consider, what is passing at the present moment in the bosom of the ocean.

We have seen, that the copiousness of springs depends on the extent and thickness of the filtrating strata, and that these strata are inclined to the horizon. We have likewise seen, that in cases of rupture and dislocation in the strata, springs may break out either laterally, as at Calstone and Pottern, or perpendicularly upwards, as in every country in which quicksands appear. But should the stratum of water, produced by rains and dew on a considerable expanse of country, and filtrating through its proper bed, as for instance, through the sand immediately under chalk, or through the great free-stone rock between Bath and Bradford, find either no vent, or one not sufficient to exaust its contents in the formation of springs and rivers; it must continue to descend over its inclined plain of clay, in its progress towards the centre of the earth, till the top covering, unable to support its pressure, shall give way and a disruption shall take place. This must naturally happen where, in the bed of the ocean, the incumbent mass of rock is least considerable.

The consequence of this disruption and discharge of water, will be a CURRENT in the direction of the filtrating stratum, dependent on the quantity of rain and subject to alternations whenever the supply proceeds from a country, which has its seasons of drought and rain. As the direction of the dip varies in different parts of the globe, so must the direction of the currents, meaning always, not the superficial, affecting navigation, but the ground currents perceptible only by the plumb line.

Now, although we cannot look into the deep, we may be certain, what must be the effects produced by submarine torrents rushing from their beds and pouring forth their copious streams into the ocean. They are two-fold, for first the momentum acquired in a long and rapid descent is not readily destroyed. This we observe in the waters of the Rhone, which for many leagues pursue their course in the Mediterranean Sea, perfectly fresh, without the most minute admixture of salt water. But if such be the momentum in the waters of the Rhone, how much greater must be that of torrents rolling down much steeper descents; and what a battering ram must they present to opposing strata of argil, sand, or other soft materials.

Such materials must be washed away, and consequently the superincumbent strata, even of the hardest rocks, must fall.

But in the second place, such a plentiful supply of water, once in motion, must inevitably dislocate much of the filtrating stratum, in which it was collected, with the clay on which it glides, and thereby let down the superincumbent strata.

This process is taking place in the present ocean, and may have existed in the former. But, however, the effect in question may have been produced, certain it is, that superior strata were undermined, and that considerable incroachments were made on the inferior strata, by which numerous superincumbent beds sunk down. Such incroachments cannot have been produced by the common agents of destruction, rain, dews, frost and wind. They must therefore have originated in the attrition of inferior currents, however caused, whilst these strata and the now habitable parts of the globe were covered by the sea.

The scattered fragments of the dislocated strata being perpetually in motion and agitated by contending currents, may have formed shingle, precisely like the alternations of the tides, on our sea shores, and the same operation may have produced bowlder-stones, which cannot have been formed by land floods and torrents.

On these scattered fragments, some angular, others, by agitation and attrition, rounded, various substances, such as clay, sand, broken shells, or the paste of these, having been deposited, may have given birth to breccia and pudding-stone.

Thus in succession various strata must have been formed in the bed of the ocean, subject to dislocation both by currents and by subterranean fire. Dolomieu confirms this notion, for he remarks, that the lava of the Isles of the Cyclops near Ætna, and of the mountains of Trezza, must have been covered by the sea, because, at the height of more than two hundred perches above them, immense quantities of shells are found.

That the portion of the globe we now inhabit, was the bed of the pristine ocean, is, I trust, sufficiently evinced. But from what I shall immediately subjoin, it will appear, that the most elevated parts of our island, and perhaps of the great continents, were once covered by the deepest water.

In the bastard free-stone we find, as I have already noticed, a spined cockle, called by Knorr, *concha anomia-ventricosa striata echinata*, and by Linnæus *anomia spinosa.* The spines of this shell are long, extremely slender, and, consequently, very brittle. These were certainly ill suited to the fluctuations of shallow water.

Between the lyas beds we have large fragments of the encrinus, with numerous and extensive branches. I have already noticed one in the cabinet of Charles Joseph Harford, Esq. at Stapleton, such as must have lived at a considerable depth in the ocean, never liable to be deserted by the tide.

The sponges and cup corals of Pewsey Vale, inclosed in round sand-stone nodules, of which they form the nuclei, evidently collected this adventitious matter in still waters, whilst each was yet standing on its stem. At a subsequent epoch the stem, by some violent concussion was broken, and thereby the nodule was set at liberty. But though detached from its base it suffered no attrition, for the fractured edge is angular and sharp, which could not have been the case, had it rolled and been subject to collision among shingle and other stones of equal hardness with itself.

The mytili of the coral rag and of the bastard free-stone have the same kind of covering, collected by corpuscular attraction in quiet water. It is remarkable, that in the iron-stone nodules of Staffordshire, the inclosed leaves are always in the middle. These therefore must have acted as nuclei, to which the matter, floating within their sphere of attraction, moved, and to which it adhered.

Bowlder-stones of enormous bulk, such as in Wiltshire, we see at Abury and Stonehenge, or such as are to be met with round Clatford, Lockeridge, and Wroughton, not merely in the bottoms, but on the hills of these most elevated districts, seem to prove, that this tract of country was exceedingly depressed, and formed a dish to receive the spoils of more elevated mountains, then covered by the waters of the ocean, because they belong to the inferior strata near the granite, but are yet found incumbent on the chalk. In great depths of water these stones must have been moved about by currents with extreme facility, and must have been liable to occupy almost indifferently either the vallies, the side long slopes, or the summits of the sub-marine elevations.

Should it be established as a fact, that the most elevated portions of our island, and the highest of the calcareous mountains, were among the deepest parts of the Antidiluvian Ocean, this will account for a fact which has hitherto puzzled the geologist. It is allowed that the analogues of many petrified shells are not found recent.

Now on this we must remark, that the recent shells we are acquainted with, are such as are either brought up by the net in fishing, or cast upon our shores by the tide, that is the shells of shallow water, whilst such as are natives of the deep remain concealed. The fossil anomia, called *terebratula*, is found in the mountains of every country, and most frequently among belemnites, ammonites, and other inhabitants of the ancient Ocean. The living anomia is found in both hemispheres, but more especially in the Mediterranean and Adriatic seas, at the depth of two hundred fathom, and deeper in caverns, whence corals are procured. M. de la Perouse met with fossil teretabulæ, similar to living ones, but he observes—"There are "marine ones never found petrified, and some petrified which have "no analogy to those found in the sea."*

Ammonites have been considered as extinct, only because they are inhabitants of deep water, for this attentive navigator met with them in the stomach of the *Boneta*,† taken at sea between the tropics, where no bottom could be found with a line of more than two hundred fathom. These were from one to four-tenths of an inch diameter.‡

Judging by analogy, we can have little doubt that fish have their *habitat*, as well as plants, insects, birds, all which delight to dwell where they may find their proper food, or migrate to those places where they can deposit their spawn. When we are acquainted with the soil on land, we know what plants, insects, and birds, we may expect to find, because each depends upon the other. Precisely the same, in all probability, it is with fish. Even when they migrate it is in search of food, and this ultimately depends on the climate, the season, and the soil.

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* La Perouse Voyages, vol. 3, p. 281.

† Scomber pelamis Linn.

‡ La Perouse Voyages, vol. 3, p. 303.

From all that I have here advanced, I trust that it will be clear, that the agents employed in dislocation have been the two most potent, with which we are acquainted, fire and water, neither of which alone will enable us to account for the effects produced, the elevation of our continents, and the disrupted condition of our strata.

GENERAL OBSERVATIONS ON THE HUTTONIAN THEORY OF THE EARTH.

HAVING established facts, and drawn such inferences from them, as appear to be warranted by sound reasoning; I shall now venture to produce a few remarks on the wild and extravagant opinions of a distinguished naturalist, to whom, notwithstanding, we have been indebted for numerous observations of inestimable value.

Science, it must be acknowledged, is advancing with rapid and gigantic strides, and every new discovery excites surprize: But it is yet too early in the day to think of forming such a system, as may account for all the phœnomena in nature. Every systematist, from Burnet down to Dr. Hutton, has with confidence exclaimed—

> More durable than brass, the frame
> Which here I consecrate to fame;
> Higher than pyramids that rise
> With royal pride to brave the skies.
> Nor years, though numberless the train,
> Nor flight of seasons, wasting rain,
> Nor winds, that loud in tempests break,
> Shall e'er its firm foundation shake.

HORACE

Such has been their exulting boast; but each adventurer has levelled the monument of his predecessor with the dust. The most distinguished of all our geologists, whose indefatigable industry traversed the Alps, and climbed even to the summit of Mont Blanc, rejoiced, when dying, that he had not lived to publish his system, which he foresaw would prove defective, like all those which had preceded his.

Our Northern philosopher, more presumptuous and daring in his flight, imagined he had discovered a *succession of worlds, with "no "vestige of a beginning—no prospect of an end."*

To religion in general this marvellous discovery is a matter of the most perfect indifference. It matters not how long the chain; we know where the first link must be suspended. But, as the truth of revelation may be rendered doubtful by this position, I shall examine how far it is agreeable to facts.

Dr. Hutton was too much of a philosopher to think of an infinite series of cause and effect, without a first cause. He was not an Atheist; but, as far as we can judge by his writings, a firm believer in the wisdom and power of the Creator. His object, therefore, in this work, was not to establish Atheism, but to justify his unbelief in Revelation, and to make converts to his infidel opinions. He acknowledges, that there has not been found in natural history any document, by which a high antiquity might be attributed to the human race, the beginning of which, as he observes, the Mosaic history has placed at no great distance; but to the earth, in its present form, he gives millions of ages, and when he is speaking of the apparent disorder and confusion in the solid parts of this globe, he says—"there is no "occasion for having recourse to any unnatural supposition of evil— "to any destructive accident in nature—or to any agency of any "preternatural cause in explaining that which actually appears."

This and many similar expressions, leave no room to doubt what was his principal object, and what the bias of his mind, when he undertook to give us his theory of the earth.

As a geologist he appeals to facts, but unfortunately his knowledge of facts had limits, and his inference from those, with which he was acquainted, are not always agreeable to common understandings, or consistent with other facts which have escaped his notice.

He supposes, that the world, we now inhabit, is composed of the materials, not of the earth, which was the immediate predecessor of the present, and in this perhaps his conjecture is well founded; but that "its materials were derived from the earth which had preceded "the land, that was above the surface of the sea, while our present "land was yet beneath the water of the ocean." Here his inference is rash in the extreme.

With the internal structure of our globe we are wholly unacquainted, for beyond the granite no eye has penetrated. This forms the barrier, the utmost limits of our knowledge, beyond which all is perfect darkness. For in these regions, unexplored by science, we have not one ray of light to guide us in our researches after truth, but every thing is left to the most vague conjecture.

In the granite we find principally silex and argil with magnesia, and in its fissures we observe molybdena wolfram, titanium, and tin, with native gold and other metallic substances: but what imagination can trace these metals to their source, or point out the origin of their inclosing earths? As little are we able to assign a productive cause for silver, lead, copper, iron, mercury, bismuth, antimony, cobalt, manganese, arsenic, and sulphur, or for basalt, which abounds with iron. All these seem to originate in that dark and fathomless abyss beneath the granite. Between these substances and the detritus of any former "vegetable world, and of continents, such as "the present," we can trace no connection.

The strata, immediately incumbent on granite, whether gneiss, micaceous schist, porphyry, argillaceous schist, or sand-stone, appear to be its offspring, and to have derived their elements from it, whilst it was yet covered by the waters of the ocean, exposed to its depredations and subject to be rent by volcanic fire. In these we trace no vestige of a vegetable world, nor marks of organic structure. These strata run into each other, and make it difficult to say, where one terminates and the other begins. Over these we have metalliferous lime-stone, then coal measures, covered frequently by impressions of fern, such as may have been carried down by rivers. Incumbent on these beds we find red sand-stone, with granulated quartz and argil, and over this the various calcareous strata above described, which are evidently the deposit of the ocean, collected from the spoils of shell fish.

In my Spanish journey I suggested, from observations made at Monjouy near Barcelona, at Toledo, and more distinctly at Salamanca,* that silicious sand-stone and grit derive their origin from granite. My excursions round Geneva confirmed this opinion, and the observations of all succeeding travellers tend to establish as a truth, what I ventured only to hazard as conjecture.

M. de Saussure, in the Col de Balme, which shuts in the vale of Champmouni, traced the progress of granite in mass to veined granite, and from this to quartzose schist and pudding-stone, with silicious cement, interposed between the primary and secondary rocks, and the most ancient of the latter inclosing elements of the former. In one of the adjacent mountains he met with the remaining rocks of this interesting chain, and observed, that in proportion as the beds of grit increased their distance from the primitive rock, which formed the base of the mountain, the quantity of quartz diminished, and the most elevated beds effervesced with acids.

Above these he saw the calcareous strata.

Thus the whole of our habitable continents and islands, are composed of materials, not of former continents and islands, but of granite covered by the immediate produce of the ocean, while our present land was yet beneath its waves.

Dr. Hutton and his friends attribute to agents natural to the surface of the earth, to heat, rains, dews, frost, and wind, effects produced by submarine convulsions and the ravages of currents, before our continents were raised above the waves. The agents assigned by him are not adequate to the effects produced; and supposing them to have been adequate, would have required a longer space of time, than other appearances in nature can admit of. For he acknowledges, that some Roman roads remain unimpaired by these destructive elements on the summits of our most elevated mountains; and lakes still exist, which, in the indefinite space of time required for his wasting operations, should long since have been filled up, and have become level plains.

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* Vol. 2, p. 89.

Mr. Playfair seems to suppose, that the granitic bowlder-stones of Mont Blanc, found on the sides of Jura farthest from the Alps, rolled down thither since the elevation of the Alps. He states the distance to be fifty miles, and the declivity to have been one foot in thirty, an inclination, says he, much greater than is necessary for water to run on, even with extreme rapidity, and more than sufficient to enable a river or a torrent to carry with it stones or fragments of rock almost to any distance.*

But here we may remark, that should we even grant the declivity to be sufficient for the transport of such enormous blocks, either by rivers or by torrents, neither rivers nor torrents sufficient for their transport can be supposed, when from the summit of the Alps to Dauphiné, the whole tract of country was one continued plain.

In the present condition of the country, should enormous granitic rocks, precipitated from the mountains, be carried down by torrents into the Rhone, to be transported by that river to a distance, they would inevitably be arrested in their course by the lake of Geneva.

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* § 345, § 346.

The existence of granitic peaks, of cataracts, and of mountain-lakes, assist us in limiting the period which has elapsed since the elevation of our present habitable earth.

By the ravages of time, and the agency of destructive elements, the craggy rocks must moulder, and must contribute to the repletion of the deepest lakes. This operation, however, seems to be but just begun, and by no means indicates "millions of ages," or a past unlimited duration.

But we cannot concede to Dr. Hutton his first and fundamental supposition, for neither rain, dew, frost, nor wind, nor all these united could produce effects such as are every where visible, and much less such as are invisible, except to miners.

Where the greatest dislocations have been discovered in coal strata, the surface of the earth is level, and no trace is to be observed of any dislocation. Surely then four or five hundred feet in thickness cannot "have been worn away and removed into the sea, more from "the country on the one side of this line than from that on the other, "and this for the extent of perhaps seventeen or eighteen miles."* The oscillation of the waters of the ocean has a tendency to level every deposit in its bed, but frost, heat, and rain, leave hills and vallies, elevations and depressions on the surface of the earth.

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* Hutton, vol. 2, p. 290.

To Dr. Hutton and his friends we are indebted for valuable facts, but from none of these can we infer "the destruction of an animal "and vegetable earth, prior to a former land." His sagacity was great, and his observations were most often just; but his general conclusion cannot possibly be granted. One animal and vegetable earth has been covered by the waves, and the bed of the pristine ocean, now elevated, is become the habitable portion of our globe. This he has fairly proved, and this accords with revelation; but beyond this all is idle speculation.

Dr. Hutton, with an imperfect knowledge of nature's chemistry, accounts for all her operations to the satisfaction of many, who ought to be considered as competent judges of his merits, but other geologists, not inferior to them in talents, are inclined to think him too hasty in his conclusions. This fault is not uncommon in the sanguine temperament.

Mr. Catcott of Bristol, a gentleman much to be commended for the ardour of his pursuit after knowledge, from the state of facts, of which he was possessed, concluded, that during the Deluge the Almighty must have created a menstruum for the purpose of dissolving every thing natural and artificial, in short all substances, excepting marine productions, and that the specific gravities then differed from what they were before or since the flood. He was no contemptible philosopher; but we must be permitted to smile at his simplicity, and to consider him as extremely rash in his conclusions. Should he not have paused a little to consider, whether his collection of facts were perfect, and his observation sufficiently attentive. Had he been fortunate enough to notice, that his fossil shells were deposited, not in confusion, mixed and jumbled together, but in families, precisely as in the bed of the sea, he might have concluded, that the pristine earth is no longer visible, and that the parts we now inhabit were, for ages, covered by the waters of the ocean. He would then have had no occasion for a menstruum, to dissolve the bones of terrene animals, with all the works of art, and every thing which could mark the residence of man, whilst it spared the shells of fish and all marine productions. Time, and more extensive observations, have given us a knowledge of facts, such as never came under the contemplation of his mind. But even in the present day, we are not prepared to account for all the phœnomena in nature, and to exhibit a consistent theory of the Earth.

Among presumptuous philosophers, I fear, that Dr. Hutton will find a distinguished place, and among his rash conclusions, we must be obliged to reckon one already noticed, although, at the time, I made no mention of his name.

The hasty inference to which I refer, is, that ere this habitable earth was raised up from under the waters of the ocean, the only consolidating Power was fire. This position Mr. Playfair endeavours to support by a dilemma. Consolidation, says he, must have been produced either by fire, or by water. It was not produced by water; therefore it was produced by fire. That consolidation cannot be prodcued by the action of water, he thus attempts to prove.

“ First then it is evident, that consolidation produced by the “ action of water must be imperfect, and cannot entirely banish the

" porosity of the mass, for the bulk of the solvent, and of the matter " it contained in solution, being greater than the bulk of either taken " singly, when the latter was deposited, the former would have sufficient " room left, and would continue to occupy a certain space in the " interior of the strata: but, &c.^{a} therefore, &c.^{a} Again, if water was " the solvent by which the consolidating matter was introduced into " the interstices of the strata; that matter could consist only of such " substances as are soluble in water: but, &c.^{a} therefore, &c.^{a}"*

On these arguments we may observe, that substances such as are not soluble in water, may be reduced to extreme tenuity, and, being diffused in water, may be deposited in the interstices of strata, and even the water itself may contribute to their consolidation, as in the process of crystallization.

It is often impracticable to say, with certainty, whether consolidation, is perfect or imperfect. Marble itself is porous, and by the air pump is proved to be so. Even our glazed earthen jars, although retentive of water are not perfect in their solidity. In the beautiful experiments of Sir James Hall, it appears that carbonic acid pervaded the substance of his Wedgwood tubes, where no flaw could be traced; and his fusible metal, when liquified by a heat approaching to redness, exuded through his iron gun-barrel, in innumerable minute drops dispersed all round it. Who then can determine when consolidation is absolutely perfect?

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* Playfair's Illustrations, § 12, § 13.

I have some glazed earthen jars, which have been used for preserves, and were conceived to be destitute of pores, till, after a lapse of years, and after having been frequently washed, they were placed as flower-pots on a mantle-piece. Here the heat produced on their exterior surface an efflorescence of sugar. This was repeatedly washed off, and as repeatedly returned.

The argument of Mr. Playfair against consolidation by water, however specious, is neither founded upon facts, nor agreeable to observation. For lime, derived from chalk, when slacked and converted into mortar, although feeble and comparatively soft, when exposed to air, yet under water hardens to such a degree as to become a solid rock, no longer permeable by the fluid from which it has derived its hardness.

We may safely therefore take the other side of Mr. Playfair's dilemma, and may venture to affirm, that the consolidation of our strata, excepting always the basaltic, and probably those of saline marble, was not produced by fire, and therefore was the effect of water.

I have stated, that in the vicinity of Bath the thin lyas beds alternating with soft clay, are inclosed between very thick beds of marl.

Now even supposing that "stratified substances, being fused under " great pressure may crystallize, and yet, from that pressure, retain their " stratification;" is it possible for us to conceive, that the thin and most compact lyas beds have been consolidated by fire, whilst the intermediate beds of clay are soft? In the depth of sixty feet we may perhaps have sixty distinct beds of lyas, hard, compact, and susceptible of the highest polish, separated by fifty-nine beds of clay. Can we imagine, that these lime-stone beds have been fused, or that the fire, by which they were fused, was not fierce enough to harden the clay?

In the clay beds we find numerous petrifactions of shells, bones, and teeth, which exhibit no signs of fusion, no fresh arrangement of parts, no change in their organic structure.

But round Bath the bastard free-stone is incumbent on a compact coral bed, as that is on a thick bed of calcarcous sand. Had fire consolidated the coral bed, ought it not to have reduced the sand into the same condition?

Mr. Playfair says—"Ask the miner from whence has come the "metal in his veins? Not from the earth or air, nor from the strata "which the vein traverses; these do not contain an atom of the "mineral."*

This last assertion is not accurately just; for M. Chaptal, by actual experiments on a large scale, found it otherwise.

But Mr. Playfair adds, "if the materials in the veins were deposited by water *in the most perfect tranquility:* it is wonderful, "that we should not find these materials disposed in horizontal layers "across the vein instead of being parallel to its sides."†

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* § 220. † § 223.

His statement appears to be unfair: for surely no one ever imagined, that materials, whether in solution or difused in water, *in the most perfect tranquility*, could be so deposited as to fill the vein. Supposing them to circulate in the veins, they must be subject to corpuscular attraction, and would therefore be deposited in layers parallel to the sides, as we have frequently observed in wooden pipes. The elm pipes at Newton Colleries, near Bath, were completely filled by an incrustation of calcareous stone. In Cornwall, we frequently find dendritical virgin copper, intermixed with red octaedral crystals. Now it is constantly observed that Metals, crystallizing from a state of *solution*, affect such forms: but small portions of metal, when fused are globular. Should, however, the dendritical copper be considered as produced by fusion; what shall we say of the red octaedral crystals? Surely they cannot be attributed to fire.

All substances concreting quietly and slowly from a state of fluidity affect their peculiar crystalline forms. And all crystals, however bulky, when broken with attention, as by the Àbbé Haüy, appear to be composed of other elementary crystals, or integral molecules, as far at least as we can trace them, and therefore, by analogy we are warranted to say, even to their primitive particles of extreme minuteness.

When the form of the crystal is the same as that of the molecule, each crystal may be considered as an accumulation of molecules, arranged by some species of polarity. When they are truncated these secondary forms are produced by accumulating additional molecules on some particular part.

Sometimes, we observe chrystals, which seem to be incipient and imperfect, but these when viewed, through a convex lens, are discovered to be absolutely perfect. Some of these take the larger crystals for their base, and rise perpendicularly from them. Others attach themselves obliquely. In one large plate of quartz, now before me, most of the original crystals, are more than half covered, that is have three of their sides concealed by fresh crystals; but some few are wholly inclosed, yet still discernible within their garment of adventitious crystals. In this curious specimen, and in all, that were contiguous to it, by far the greatest number of the original crystals when viewed in one direction appear distinct and naked: viewed in the opposite direction, all are completely hid by the adventitious crystals. These shew several epochs and distinct operations.

I have numerous crystals of quartz, containing crystals of tin, and one fragment of fluor, in which is visible a cluster of tetraedral crystals of copper. Some quartz crystals, I have seen with each a drop of water, and it is said, that in the Cabinet of Monaco, two large crystals contain, one about a glass full of water, the other moss.* At Tain, where the hermitage wine is made, the rock is granite and the crystals of quartz contain mica in them.†

At the Land's End, in Cornwall, near the Loggan Rock, I have seen vast blocks of quartz, containing perfect crystals of shörle in long prisms, shooting undisturbed in all directions. To these the quartz conforms. Agreeable to this fact we find another, noticed by Sir James

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* Tavernier's Travels.

† Saussure.

Hall. He observes, that in granites, such as contain quartz and field spar, it frequently occurs, that the field spar is seen with the form of its crystals distinctly defined, whilst the quartz is a confused and irregular mass, being almost universally moulded on the crystals of field spar. Now, were it true that all granite is formed by fusion, the very contrary ought always to take place, because shörle and field spar are very easily melted, and quartz resists the greatest efforts of heat that have hitherto been applied to it.* Calcareous earth, indeed, mixed with quartz, will assist its fusion; but then in fusion these substances do not crystallize separately.

How little do we know of silex! yet Dr. Hutton, and the disciples of his school, argue as if they were perfectly acquainted with its origin, and with all its properties. It was indeed universally considered as insoluble in water. But now, every day brings to light some new fact respecting it. It has been for some time noticed in the geyzer springs of Iceland, and was conceived to be peculiar to those springs; but, after the most able chemists had, for half a century, exerted all their skill in vain, Dr. Gibbes detected it in the Bath waters. The sprudel springs at Carlsbad, in Bohemia, annually yield more than seventeen thousand pounds weight of this earth, held in solution, without the aid of fossil alkali †

This effect has been attributed to intensity of heat, but now, without the assistance of such heat, the bamboo of India produces the silicious substance, called tabasheer. Silex has been also found abundant in Dutch Rush, the equisetum hiemale of Linnæus, in the cortex of the sugar-cane, and latterly my old acquaintance Hassenfratz, after a careful investigation of this subject, and repeated trials on various vegetables, found, that one hundred grains of lixiviated ashes of wheat yielded forty-eight grains of silex; rye gave him sixty three grains; oats sixty-eight; and barley sixty-nine. Humboldt assures us, that in the province of Santa Fé, a reed called *guaduas* deposits a silicious juice, which resembles opal.

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* Phil. Trans. Ed. III. 10.

† v. Kirwan.

Nay, that silex may be suspended in water, in a state of diffusion, as minute as if it had been dissolved, has been proved by Bergman, who met with it in the waters of Upsal.* In this divided state he found it soluble in all acids, and Klaproth dissolved it in water.

Every day conveys to us some new and valuable information, respecting the properties of silex. It may be easily sublimed, and from an aeriform fluid may be condensed again. If you put fluat of lime, finely powdered, into a pewter vessel, with an equal weight of flint glass, and pour upon this mixture sulphuric acid, you will have new compounds. Put the containing vessel into a hot water bath, and evaporation will take place. If then you dip a sponge in cold water, and with it condense the vapor, in a short time your sponge will be covered by a crust of silex.

Now this operation may be easily conceived as taking place in the bowels of the earth, where all the articles essential to the process are found, and meet together in abundance.

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* *v.* Irish Phil. Trans. vol. 5.

The agatized coral, dispersed over the surface of the soil at Tisbury, between Hindon and Shaftesbury, is evidently not the effect of fire, but of water. All its vacuities, formerly the habitation of the little animal, are full of white agate, the solid parts of the coral have been carried off, their place has been supplied with grey agate, and the interstices between the stems are occupied by flint, of a dark colour. These appearances indicate three periods. The same circumstances take place, and the same observations will apply to petrified alcyons, and to every species of silicious zoophytes, which are found in great abundance in the green sand bed of Pewsey Vale, in which they seem, when recent, to have been deposited. Here they perished, and their place has been occupied either wholly, or in part by flint. When they have happened to preserve their fibrous texture after the softer and more perishable parts have been carried off, they have retained not only their form, but their organic structure. But when the whole substance of the animal had vanished, before filtration took place, then the form alone remained; and in such cases no organic structure can be seen. When several of these silicious marine productions meet together, and compose one shapeless mass; we have then what may with propriety be called amorphuous flint.

Albert Fortis, observing flint-stones among strata, mostly single and placentiform, with rounded borders, delivered it as his opinion, that we should seek their origin exclusively in the Mollusca.*

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* Oryct. de l'Italie.

Whatever comes from the pen of this distinguished naturalist is worthy of attention: but his opinion does not accord with my observation, for in this country flints contain a great variety of zoophytes, whilst of the mollusca tribe I find, although many, yet, excepting numerous species of echinites, comparatively few.

M. Lassone assures us, that a grit-stone, which had been broken a year before, was at the end of that time covered with a silicious crust, as hard as agate. This relation we receive upon his testimony: when confirmed it will be a valuable fact. So likewise will the declaration of a Cornish miner, who repeatedly affirmed to me, that in breaking open a cavity he once discovered quartz crystals, perfectly flexible, but that, on the admission of air, they hardened.

Approaching towards granitic districts, we observe the mountain lime-stone, composed principally of encrinites, corals, and some few bivalves, cemented by a fine calcareous paste. In these strata I have noticed regular and extensive beds of corallines and madreporæ, pure and unmixed, yet cemented to each other by a calx of iron. These shew no signs of fusion, nor is it possible to conceive, that they have been consolidated by fire.

Dr. Hutton's observations on coal are specious; but, unfortunately for the credit of his hypothesis, untoward facts come in the way of his conjectures, and prevent our ready acquiescence in his opinions. He supposes hard coal, such for instance as Kilkenny produces, has been deprived of its bitumen for want of that degree of pressure which effectually retained this inflammable substance, at a greater depth, in melting coal. But surely the laminated structure of some coal veins, with the distinct appearance of fern leaves, looks rather like aqueous subsidence than fusion. Again, it has been frequently observed, that the inferior strata, subject to the greatest pressure, have lost their bitumen, if they ever had it, whilst the superior strata have retained it, as I have particularly noticed in South Wales and Derbyshire. Once more, supposing the bitumen to have been expelled by heat in the Kilkenny coal—should not the same heat have dissipated the sulphur of the pyrites, which it contains, and by which its plumbago has been found studded?

Mr. Playfair, in his vindication of Dr. Hutton's Theory, traces the origin of *coal* to the *daily* waste of animal and vegetable substances on the surface of the earth. This disengages a great quantity of oily, as well as carbonic matter, which, with whatever element it is at first combined, may be ultimately delivered into the ocean.*

But should this operation be *daily*, i. e. incessantly proceeding, it would not produce distinct beds of coal of various thickness, alternating with beds of clay, of silicious sand, and of calcareous earth, equally, and at the same time, conveyed into the ocean.

By what process can we suppose these substances, thus blended, to have been separated; and being separated, to have alternately subsided without the least regard to their specific gravity?

The notion of these oily and carbonic materials being *chemically* united to water, to be from thence precipitated, and precipitated at various and uncertain intervals, is perfectly novel. It has never been imagined that the fern leaves, commonly found on the roof of coal, were chemically united to water, and if not, it must certainly be a most remarkable coincidence, that they should be deposited precisely subsequent to the precipitation of the oily and carbonic matter, to which Mr. Playfair has attributed the origin of coal.

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* Playfair, § 6.

Dr. Hutton represents the assemblage of our *continents* as coming out of the ocean, a solid mass.* But then he qualifies this expression by adding "which surely it is *in general*, or in *a great degree.*" He then supposes, that all *vegetable soil* is produced by the dissolution of *solid* rocks, that this vegetable soil is the *food of plants*, and is wasted by their growth; and lastly that, allowing no further degradation to the surface of the earth, vegetation would cease and perfect sterility ensue.†

How wild! how unfounded are these suppositions! The soil on our most elevated downs increases by the mere process of vegetation; and the well-known experiment of Mr. Boyle on the willow tree, demonstrates, that plants will grow without the degradation of a rock. Numerous experiments, tried by me in two successive years, communicated to the Board of Agriculture, and published by the Bath Society, demonstrate, that neither argillaceous, silicious, nor calcareous earth is the food of plants, because both wheat and cabbages increased, and came to perfection by means of water, air, light, and a supply of vegetable matter, such as had passed through the bowels of a horse.

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* Vol. II. p. 186.

† Vol. II. p. 186, 219.

In these experiments it appeared, that independently of vegetable matter contained in it, the soil only gave stability to the roots, passage to the air, and a retentive substance for the water; for the soil made use of was coarse and well-washed quartz sand.

Lichen and sedum grow on the surface of the solid rock. So likewise do the mosses, and these lay the foundation for a vegetable soil.

As to his notion of our continents coming out of the ocean a *solid mass*, we may remark, that the surface of the earth exhibits only the crops of the several strata, which I have noticed above, and that these are precisely the same in depth as on the surface, and consequently, that they are not the degradation of rocks, which came out of the ocean a solid mass. If on the surface we find clay, the same stratum is continuous in its dip: if sand, we are certain, that we shall find the same bed, as we descend in depth. These then have not been degraded by heat, rain, frost and air, since the time of their elevation from the bottom of the ocean.

On the whole we may fairly conclude, that it is not "by the "operation of the atmospheric elements, that high mountains have "been degraded and the vallies of this earth hallowed out." High and rugged mountains indeed are liable to be degraded; but, when they shall have attained a certain angle, vegetation will follow, the substratum will be protected, and they will arrive at their quiescent state. As to vallies, they were formed ere our continents appeared above the waters of the ocean. This subject I have already sufficiently discussed.

In treating of the consolidation of strata, I have in some measure anticipated, what I should have had to say against the opinions of Dr. Hutton, as far as they relate to it. What I have there said, and the arguments I have here adduced, will, I trust, be sufficient to convince the unprejudiced, that our northern sage has been too hasty in some of his conclusions.

His observations on volcanic productions are highly valuable: but I can by no means acquiesce in his opinion, that fire is the only consolidating power in nature, when I see so much performed by water.

Among the wildest, the most unphilosophic notions of Dr. Hutton, may be reckoned his opinion, that all our mountains will be levelled with the plains, that our continents will gradually waste away, and that all our habitable earth will sink under the waters of the ocean.

But a more able naturalist has demonstrated, that our most rugged mountains, by a natural process, can only terminate in verdant hills; that in time the limpid stream will cease to be destructive to its banks; and that every sea coast, must ultimately be protected by its strand.*

I shall not repeat his arguments, as they must readily occur to the recollection of every one, who has paid sufficient attention to this interesting subject.

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* v. De Luc's Letters to Dr. Hutton, in the Monthly Reviews for 1790 and 1791.

GEOLOGICAL CHRONOMETERS.

M. DE LUC, to whom geology is indebted for more numerous facts, than have ever been presented to the world, before he brought them forward to our view, is the first philosopher, who thought of looking to this habitable earth itself for the record of its birth. He has examined, with more than common sagacity, numerous physical chronometers, and demonstrated, that these agree with revelation. By their means we may ascertain the era of the grand revolution, which has happened to our globe, and bring it, as nearly as it is requisite, to that, which Moses himself assigned to this marvelous event.

In all his labours, his principal object has been to promote the happiness of men by the confirmation of their hopes, and he was well aware, that this purpose will be effectually answered by the examination of these natural chronometers, which cannot possibly deceive us.

Deltas, at the mouths of rivers, may be regarded as the first of these, because we cannot refer beyond a given time the date of their commencement. Such accretions I particularly remarked in my Spanish travels at the mouth of the Ebro, and such, from remote antiquity, have been noticed at the mouths of the Nile.

The *great lakes* exhibit similar accretions at the entrance of rivers into them. Thus it is in the Lake of Geneva, as particularly noticed by M. de Luc. This forms an excellent chronometer. For had our continents existed, myriads of ages before the time assigned by Moses for the Deluge; the Lake of Geneva, had been long since, filled with the sediments of its waters and had become one extensive plain; because not an atom of this sediment either escapes out of the lake, or is deposited at any considerable distance from its entrance into it. The Rhone, at its departure from Geneva, having deposited all its impurities, is perfectly limpid; and, although thirty feet deep, does not appear to have the depth of thirty inches.

Lesser lakes have been successively filled, and have been converted first into marshes and then into meadows. M. de Luc has given in the first volume of his Geological Travels, a most interesting description of numerous lakes in Mecklenburg and Sleswigh, which in process of time have become dry meadows.

He remarks, that in this conversion, reeds are the most powerful agents, and in the progress of conversion always form the van. The reason is obvious, for it is universally observed, that they raise themselves above the water, from a greater depth, than any other aquatic plant. In the second zone we find scirpus cæspitosus, scirpus maritimus, scirpus pauciflorus eriophorum polystachyon, eriophorum vaginatum, equisetum palustre, equisetum fluviatile and equisetum hyemale, with numerous bog plants.

Among the plants which appear in proportion as the mass becomes more solid, are, ledum palustre, vaccinium oxycoccos, comarum palustre, erica tetralix, and some of the aquatic grasses, then the poas and the meadow plants.

When the sphagnum palustre has established itself in wet land above a bed of clay; *peat* begins to grow, and constantly increases. Near Lough Erne, at Sir James Caldwell's, I saw an extensive bed of peat, ten feet in thickness, covering a Roman pavement; and M. de Luc refers us to one in the Duvels Moer, near Bremen, which is forty feet thick, black in the bottom, and, when dry, resembles coal, both in its fracture and in its combustibility.*

The old people near the Baltic remember lakes, which, having been filled with peat, are become good meadow land; and, when sand has been driven by the wind over their surface, have been converted into rich arable land.

These peat meads, therefore, are good chronometers, because the lesser lakes have been long since filled, and the greater lakes are in the act of being filled.

Such likewise are *bays* and *creeks*, because these, in process of time, become choaked with sand or slime, and are converted into marshes. This operation is regularly and constantly proceeding, and its progress will assist us to establish infallible chronometers.

It is well known that navigable rivers, like the Thames, require constant attention, and very expensive operations to preserve them free from shoals. It is equally notorious, that bays and harbours, if neglected, become dangerous to navigation, and are at last filled up to such a degree, as to be no longer bays, but sea beaches, covered only by high tides.

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* Geol. Travels, vol. I.

Estuaries are certainly among the best chronometers, because as long as the present continents have subsisted, so long have the waters of the sea and of the land united to replenish them, and to convert them into salt marshes. In consequence of this operation, cities which, like Truro, in Cornwall, once were sea-ports, now carry on their trade in small craft; and others, which formerly were accessible at all times, are now, like Mevagizey, dependent on the tides, and at low water see all their vessels laid dry upon the strand. In process of time Mevagizey will be reduced to the same state with Truro, and every estuary will cease to feel the influence of tides.

In conformity with these observations of M. de Luc, are those of Dr. Jameson, who says—In the Baltic many bays, which were navigable within the memory of man, are now filled and covered with grass. Several harbours in Lapland, that formerly admitted vessels, are now between three and four thousand paces from the sea; and at Helsingor are iron works, in places which were covered by the sea about eighty years ago. The whole of the ancient kingdom of Prussia appears to have been formed in this manner. It is said that the sea reached as far as Culm within the period of human history, and the city of Dantzic, several hundred years ago, was close to the sea shore.

Drift sands, in given circumstances, form good chronometers. For this observation we are indebted to M. de Luc, the younger, who, describing the operation of the Lybian sands, which, driven over the Western borders of the Nile, cover the most elevated structures of villages and cities with their surrounding plains, observes—"These sands, anciently far remote from Egypt, now doom to sterility "a land which was once remarkable for its fertility." If, then, our continents were as ancient as Dr. Hutton represents them to be, no traces of the habitation of man would appear on the Western margin of the Nile. When Egypt was the granary of the East, and fed the Western provinces of Asia, these Lybian sands had not approached her borders.

Bordering upon Egypt we find another chronometer. For when Alexandria was the emporium of the world, the navigation of the red sea was not attended with danger on its coasts, nor were its ports blocked up with reefs of *coral*. But now shoals have progressively increased, and in process of time the Isis ochrasia, with other zoophytes, will wholly obstruct the navigation of this gulf. The *reefs*, therefore, formed by the numerous genera of zoophytes, are a good chronometer.

Mouldering cliffs are excellent chronometers. Each has an accumulation of fragments constantly rising against the scarp. This in time will vanish, and instead of cliffs there will be hills, occupied by woods, by pasture, or by tillage. Were the continents as ancient as Dr. Hutton conceived them to be, there would be now no cliffs, and the whole earth had long since arrived at its quiescent state.

From all these chronometers, consisting in effects, which result from known causes, operating since the existence of our continents, and of which the progress within known times are indicated by monuments, we may safely draw this conclusion, that our continents are not of a more remote antiquity than has been assigned to them by the sacred historian in the beginning of his Pentateuch.

GEOLOGICAL CONJECTURES.

HAVING established, as I trust, to the satisfaction of my readers, the existence of an universal deluge agreeable to the Mosaic History; I shall consider some few of the conjectures which have been suggested by geologists, and which appear to be the most worthy of attention.

I.—It was the opinion of Varenius, that the greatest part of China was gained out of the sea, raised up and atterrated by the yellow river. This notion he was led to conceive by the flatness of an extensive coast, bounded by most elevated mountains, a circumstance which has not escaped the attention of more modern travellers.

Sir George Staunton, struck with this flatness, and with the uniformity of the country, through which he passed, considered it as formed subsequent to the existence of the more elevated portions of our globe, and thought, that formerly the sea must have bathed the feet of the Tartarian mountains.

In fact, the Eastern coast of China is so flat, in 31° North latitude, that mariners find only twenty-five fathom water at more than thirty leagues from land, whilst on the coast of Tartary, in latitude 44°, at two leagues from land, they have an hundred and forty fathoms.* That the whole of the country in question, has been formed by the detritus of the Tartarian mountains is probable; but then it still remains to be determined, at what period this alteration took place.

Buffon asserts, that the sea is constantly moving from East to West, and must ever gain on the Eastern coasts, whilst it is losing on the Western.† But supposing China to have been gained out of the sea by mud and sand from the yellow river; the sea must have lost in the East instead of gaining, as stated by the French Philosopher. The Delta of Egypt presents a similar phœnomenon, respecting which there are two opposite opinions. Dr. Shaw was persuaded, that the deposits of the Nile, continually protruding themselves into the sea, increased the Delta. He remarked, that Damietta, now twelve miles from the sea, was A. D. 1243, a sea port; and that Fooah, formerly at the mouth of the canopic branch of the Nile, is now, after a lapse of three hundred years, more than seven miles above it. He says, that between Rosetta and the sea, the land has gained half a league in forty years.

Bruce, on the other hand, observes, that a strong current sets constantly to the Eastward, and the Etesian winds blow all summer from the West of the North, so that it is impossible, that the mud of the Nile can go so high to the windward as any of the mouths of that river. It is thrown on the Coast of Syria, and cannot make this addition to the Land of Egypt, which Herodotus supposed. Besides Alexandria is too high to have been ever overflowed. Nor has any considerable change taken place for the last three thousand years, nor has any considerable accretion been indicated by the Nilometer. He observes, that the land of Egypt at the foot of the mountains is the lowest, the first overflowed and the longest covered with water, for the river runs upon a ridge, and instead of adding very frequently diminishes the soil, and is the common cause of famine, by sweeping every thing before it.*

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* La Parouse's Voyages, vol. 4, p. 350.

† Tom. I. p. 387.

Near the mouth of great rivers, the Cavery, the Ganges, the Indus, the Rhone, the Rhine, the Weser, the Elbe, the Oder, the Ebro, and all the Spanish rivers, we may remark the same appearances. The great rivers of America, the Amazons, Oronoco, la Plata, Missisippi, before they get to the sea, run through extensive plains.

All the country adjoining to the *Missisippi* is marshy for near fifty miles, and apt to be flooded for fifteen miles. This vast plain is intersected by numerous rivers, which, uniting, run into the *Missisippi*, and extends from the Apalachian to the Western mountains of the Californian Sea. Even our more humble Thames flows through a level country, now deserted by the sea. To the North we have Hounslow Heath, and to the South the level country between the river and the Banstead Downs. In the former, the descent from the North-west is little more than one foot in a thousand, in the distance of five measured miles, as appears by the report of General Roy, in the Philosophical Transactions.†

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* Bruce, vol. 3, p. 19.

† Vol. 57, p. 385.

That the Thames has not formed this plain by the usual deposits of a river, seems probable, from the shingle accumulated on Shooter's Hill, Blackheath, and the high hills in the vicinity of Croydon, as I have already particularly noticed. Indeed the greatest part of Essex is alluvial, yet certainly not the deposit of its rivers.

That the alluvial strata of Essex are not the deposit of its rivers, may be demonstrated by its extraneous fossils. These are of two kinds, some found in the fragments of our calcareous strata, petrified, and each distinctly shewing the stratum from which it originally came, and in which, as I have noticed, the shells are deposited in families. But mingled among these are the spoils of granitic mountains, and numerous fossil shells, of different species from any of the former, *not petrified*, nor appearing in families, extremely brittle, yet found in the most perfect state of preservation. They have a striking affinity to the shells of the country surrounding Paris, and to those of Hampshire, as described, under the direction of Dr. Solander, by Brander, and published in his inestimable work. They are the shells of distant climates, and are never found recent in our seas.

From all these facts it is not unreasonable to conjecture, that the greatest part of China and of Egypt, with the low and level country near the mouth of great rivers, as habitable portions of our globe, may be attributed to depression of the sea, occasioned by the sinking either of some extensive continent, or of some considerable island. From these considerations I am disposed to credit the report of the Egyptian priest to Solon, as related by Plato in his Timæus, that the great island of Atlantis did sink down into the ocean.

This report will appear more probable, when we consider that in Mexico were found crocodiles, apes, and such animals of warm climates as could not have come, like other quadrupeds of cold climates, by the frozen regions of the North. There must, therefore, have been formerly a communication between either Asia, or Africa and America, which now exists no more, and it is possible that some great island, or many smaller islands may have sunk into the deep.

The changes in our globe within the memory of man, or indeed within the reach of our most ancient records, are inconsiderable.— Hence we are ready to conclude, that the islands, continents, and ocean, are the same as they appeared to our progenitors, immediately after the convulsion, which produced the deluge. It is true, the descriptions given by Polybius of the Euxine, the Bosphori, the Palus Meotis, the Propontis and the Port of Byzantium are as applicable to the present state of things, as they were at the writing of that history; and the Isthmus of Corinth is apparently the same at present, as it was two or three thousand years ago. Yet important changes may have taken place in the interval, between the general deluge and our earliest records.

Should we be disposed to credit traditional reports; that of the Samothracians, as transmitted to us by Diodorous Siculus, will be highly interesting, because it is confirmed by modern observations. They relate, that anciently a deluge, occasioned by the bursting of the Euxine, extended over the coast of Asia Minor and desolated Greece. In support of this tradition, we may refer to the remarks of Professor Pallas, in his Russian travels. According to this distinguished philosopher, the same sea shells are found on the extensive plains occupied by the Kalmucks, between the Volga and the Ural, as in the Caspian; and near the former of these rivers are strata of clay, not less than twenty feet in thickness, strongly impregnated with sea salt. Nay, so abundant is salt in the lake of Altan, that four thousand men are frequently employed to dig it, and more than one thousand are engaged for five months together. And it is particularly noticed by the Professor, that pectens, found in the clay of this lake, are precisely the same as those of the Caspian sea. From his own most accurate observations he was persuaded, that all this tract of country, even to lake Aral, formed an extensive sea, which washed the feet of Causasus, and united the two enormous gulfs of the Euxine and the Caspian. Beyond these limits the mountains contain petrified sea shells and corals, the analogues of which do not exist in either of those seas.*

Foster, in a Memoire published in the Gottingen Magazine for 1780, says, but on what authority I know not, that the separation in question took place about one thousand eight hundred years before the Christian era.

What may be considered as demonstrated with respect to the bursting forth of the Euxine, has been, but perhaps too hastily, suspected to have taken place with regard to the Baltic. Certain it is that the immense plains from Petersburg to Pultowa, and the greatest part of lower Saxony, are still a morass, and further Southward are shingle, sand, and sea shells.* It should however be ascertained, whether the shells are those of the adjoining seas.

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* Pallas's Voyages, tom. v. p. 188.

Since then such changes have taken place beyond the reach of our most ancient records, we may readily conceive, that the state of the earth, immediately after the deluge and at the present time, must be so widely different, as to make it difficult for us to give a satisfactory answer to all the questions, which have been proposed by infidels, respecting the very brief and compendious relation of our sacred records, when describing the universal deluge. In such difficulties it is sufficient for us to have vindicated the character of the Historian, to have ascertained his strict regard to truth, and then to have suggested such solutions, as are not merely possible in themselves, but come within the bounds of probability. As such I have ventured to bring forward the conjecture, that the report of the Egyptian priests to Solon is agreeable to truth, because it is not only supported by presumptive evidence, but presents a satisfactory solution of many difficulties, which have been suggested by inquiring minds.

II.—It was the opinion of Mr. Edward King that by the deluge the earth shifted her poles.

This must be considered as a pure geological question, with which the Mosaic account of the deluge has no concern. It is a curious fact, that shells peculiar to warm climates should be discovered petrified and deposited by families in the colder regions of the North, and that those of a cold climate should appear even in the Torrid

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* *v.* Kirwan's Geological Essays, p. 91.

Zone. This wonderful phœnomenon gave birth to the conjecture, that the poles have shifted, and this conjecture is in some degree confirmed by our having reason to suspect, that the Northern and Southern hemispheres are not perfectly alike, nor the earth equally compressed at both her poles.* Supposing the earth to have been fluid and homogeneous; this spheriod must have been accurately elliptical. As this however is not now the case; as sea and land have changed their places; and as extraneous fossils indicate a change of climate; my much-lamented friend conjectured that the original poles have been disturbed.

It must be confessed, that ground currents in the ocean may transport heavy bodies from one climate to another: but this agent is not adequate to all the effects produced, nor will it afford a satisfactory solution of the difficulties, which immediately present themselves to the mind, not merely of the geologist, but of the astronomer. Time, and more extensive observations, may remove our doubts.

III. In ascending up from granite, the first calcareous rock I have noticed is mountain lime-stone. This seems to be principally composed of the encrinus and a rich assemblage of corals. The species of bivalves are comparatively few. The superior calcareous strata exhibit progressively a greater variety of animal productions.

This progress seems to indicate successive periods, and periods of uncertain length, which in scripture language, as it is conjectured, may have been denominated days. Certain it is, that we have no other measure for time but the motion of bodies through a given space. Our moving body is the earth itself in its annual orbit and in its diurnal revolution, the latter of which is marked by the succession of night and day, that is, of darkness and of light. But as these are dependent on the sun, strictly speaking there could be neither of them before its existence; yet, in perfect conformity to prophetic language, the term *day* may be referred to *period* in general, without meaning to restrict the word to its present acceptation.

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* v. Playfair's Illustrations, § 440.

IV. *Chalk* appears to have been one of the last deposits of the ocean, and it has been conjectured, that it originated in other calcareous strata, which are entirely composed of shells, either whole, broken, or reduced to paste. The superior beds of chalk are pure calcareous matter, but, as they approach the sand stratum, they degenerate, and to a certain degree become mixed with it. It has comparatively few shells or extraneous fossils, and these are not distributed in families like the fossil shells of other strata. It resembles lime, and like it may have been produced by fire, perhaps by that volcanic fire which brought our continents to view. It seems to have been diffused in water, and in this state to have entangled the few shells deposited in the interval of time between its ejection from the mouth of a sub-marine volcano, and its subsidence at the bottom of the ocean.

If, whilst it was thus diffused, or whilst it was yet in the bowels of the earth, it should have met with vitriolic acid, this would account for the formation of gypsum, which in Spain, and particularly in Arragon, as it does in Sicily, occupies the place of chalk. As for the acid, we can easily account for its formation, because pyrites abound in all mineral veins, and the combustion of its sulphur produces vitriolic acid. In the marly clay of Shotover, near Oxford, we find much pyrites and many oyster-shells, and, where the former appear to have been decomposed, we observe the shells corroded, and covered with crystallized *gypsum*. But when the clay is charged with pyrites, and is remote from calcareous matter, we never fail, by the combination of the vitriolic acid with clay, to be supplied with *alum*.

Flints appear to be allied to chalk, and may have been formed in two several ways, some evidently by filtration, others probably by fusion. They are no longer fusible without the assistance of an alkaline body. This the silicious substances, such as the quartz of granite, could meet with in the combustion of sea weeds, and supposing them to have been fused, and to have continued in a white heat, the potash must have been sublimed, and the residue must have remained infusible.

I have numerous specimens in my cabinet, and I have observed some in Parkinson's museum, in which a silicious paste appears to have entangled the marine productions, chiefly echinites. These probably were formed by fusion.

But in the vicinity of Pewsey we have innumerable flints, which, when broken, appear to have contained sponges, corals, alcyonia, and other zoophytes. In these, the silicious matter appears either to have taken the marine productions for their nuclei and to have inclosed them, or to have merely occupied the place, which they left empty, as they progressively decayed. Many of these smooth coated flints are hollow, and many contain their nuclei in a state of petrifaction, yet distinct from the garment, in which they are inclosed. These seem to indicate filtration as the means of their production; but the agatized coral already noticed, in my opinion, puts this matter beyond the limits of conjecture, and terminates in certainty.

V. Granulated marble, by its crystalline appearance, and by its vicinity to volcanic regions, leads me to acquiesce in the opinion of Sir James Hall, that it has passed through fire.

OF THE GREAT IMPORTANCE OF GEOLOGY.

I.

THE science of geology is of vast importance to a gentleman of landed property, because it enables him to estimate the value of his estates, and to adopt the improvements, of which they are most susceptible.

The nature of the soil depends on the strata, from which it is derived. This may be either calcareous earth, clay, silicious sand, or a mixture of these, constituting either *marl*, that is, clay and calcareous earth united; or *loam*, which is marl, with sand; or *fullers' earth*, which is clay, with calcareous earth, magnesia, and a small proportion of iron. The *loam* may likewise be impregnated with iron, and then forms the richest soil of Worcestershire, on the red ground stratum.

These soils are favourable, each to its peculiar set of plants, which therefore become indigenous, whilst others seem to be aliens, not readily naturalized, because not suited to the soil.

By way of example, I will here subjoin a short list of such as occur to my recollection.

I. In calcareous soil, whether chalk or lime-stone, we observe—

Anthyllis vulneraria
Asperula cynanchica
Clematis vitalba
Cratægus aria
Hippocrepis comosa, and other leguminous plants
Ligustrum vulgare
Serapias latifolia, in dry and shady woods
Lotus corniculatus
Ulex Europæus, on sand, but not confined to calcareous sand
Festuca ovina
Poa cristata
Briza media
Poterium sanguisorba
Thesium linophyllum
Trifolium repens.

II. In silicious sand, more especially when maritime, we observe—

Agrostis setacea
Arenaria rubra
Aira præcox
Aira carophyllea
Arundo arenarea
Carex arenarea
Cochleara coronopus
Eryngium maritimum
Festuca maritima
Onopordum acanthium
Plantago maritima
Salicornia fruticosa
Salicornia herbacea
Salsola fruticosa
Salsola kali
Sedum anglicum
Spartium scoparium
Erica tetralix, three species in Engl.
Erica vulgaris
Tilia muscosa
Trifolium arvense.

III. In clay we observe—

Aira canescens
Aira cæspitosa
Aira cærulea
Carex, twenty-seven species
Juncus, common, but not confined to clay, because it is peculiar to springy land

Orchis conopsea
Orchis maculata
Orchis latifolia
Phleum nodosum.

IV. In peat land and bogs we find, as most essential to them—

Sphagnum palustre

In all such lands we notice—

Anagallis tenella
Drosera longifolia
Drosera rotundifolia
Eriophorum polystachion
Eriophorum vaginatum
Equisetum arvense
Equisetum fluviatile
Equisetum hyemale
Eupatorium canabinum, in watry banks
Lythrum salicaria
Menyanthes trifoliata
Orchis conopsea
Orchis latifolia
Serapias longifolia
Schoenus mariscus
Scirpus, five or six species
Vaccinium oxycoccos.

Such commonly are the plants spontaneously produced. But since the several strata come in orderly succession, and by proper mixture correct the imperfections of each other; the skilful geologist can avail himself of his knowledge, to improve his land and render that productive, which, in its own nature, is most unprofitable.

Is the soil a hungry sand? He knows at what depth he is to look for marl or clay. Is it a stubborn clay? He is not ignorant where he may expect to meet with sand or loam.

Again, should his land be wet and full of springs? Should it be covered with rushes? or should he find it perfectly a bog? He will not be at a loss how to remedy these evils, not by surface draining, but by a less expensive, less injurious, and more effectual process.

Surface draining is subject to many imperfections. It is, in some situations, exceedingly expensive. It scorches the land in summer. It wastes the water, which, if collected, might be profitably employed for irrigation. The drains are apt to be choked, and are often inadequate to the purpose, for which they were designed.

In *deep drainage* one channel may be sufficient; the land may retain its proper moisture, and the collected springs may form a stream either to turn a mill, or to fertilize a meadow. Thus, at Tracey Park near Bath, where many hundred pounds had been expended, without the least advantage, by surface draining, Mr. William Smith cut off the springs, which had poisoned the estate, conducted them to a distant meadow, which stood in need of water, and thereby doubled the intrinsic value. The same success, in both respects, attended this able engineer at Wooburn, where Elkington had failed.

It is not my intention to write a treatise on this new art of drainage. This will come with more propriety from its inventor, W. Smith, but the general principles, on which this art is founded, must be obvious to every one, who has paid attention to what I have delivered on strata and on springs. It is the application only that requires sagacity, and in this Mr. Smith excels.

When it is remembered, that springs originate in strata of water; it will be obvious, that by cutting through a stratum of water, all the springs below this trench must fail. The only question then is simply this, Where shall the trench be made? To answer this inquiry a man of science will consider, in what direction the strata dip, and will recollect, that in England the natural dip is to the South-east, but that, by occasional dislocation, the dip may be inverted, or there may be troughs. He will remember also, that by disrupture in the covering, whether of chalk, marle, clay, or solid rock, springs will rise andquicksands will appear. These are circumstances, that require a vigilant attention. It was by the exercise of this vigilant attention that Mr. Smith at once discovered, where he was to make his trench at Tracey-park; because it could not escape his notice, that between Lansdown and the Severn, the natural dip of all the strata is inverted.

II. The science of geology is no less important to civil engineers, who direct canals, that in crossing the measures of a country they may know before-hand what strata they shall meet with, and where they may seek clay for puddle stuff, or, by varying their line, may choose a stratum both retentive of water and easy of excavation. It was probably accident alone, that led the Wilts and Berks Canal Company to carry their line North East from Symington, in the thick bed of marl and clay which lies between the coral rag and the Kelloways rock. Had they taken their direction more either to the East or to the West, the expense of their undertaking had been more than doubled: but in recompence they would have commanded an abundant supply of water.

Most canals are distressed for want of water, because either they are above the springs, or they are not permitted to derive a supply from mill streams. A knowledge of geology will, in most situations, relieve the engineer from distress, and teach him distinctly to what distance he must drive a level, or to what depth he must sink his shaft, that he may find ample supplies of water, such as no one can claim, because they no where break out in springs, till they issue either in the narrow seas, at the bottom of the ocean, or in the great abyss.

It was this knowledge, derived from Wm. Smith, which enabled Bevan to direct his drift into the chalk hills at Tring, by which he secured a supply of water for the Grand Junction Canal.

Even, where water is abundant, much geological knowledge may be required in making a canal. For instance, we will suppose a canal to have been constructed in faulty ground, on the hanging of a hill, above a river, and below the proper level of the springs, which therefore undermine it, and, washing away its bed of clay, occasion in the first place leaks, and in the next place numerous and most expensive breaches.

To prevent these evils, the unskilful engineer may drive drifts under his canal to carry off these annoying springs. But after all his labour and expence, leaks and breaches will take place, his banks may slide down the hill, and his navigation may be interrupted for a considerable length of time, till, at a great expence, he has restored them.

In such circumstances, the skilful geologist will detect the origin of these springs, and having found them above the level of his canal, will cut them off by a drift into the hill, and thereby derive an additional supply of water for his canal, instead of leaving these springs to undermine it and wash away its bed of clay.

The canal adventurers themselves should be acquainted with the strata, that they may be competent to judge of the articles, which may be found in the line of their canal, and thereby to estimate their profits. When articles in great request, such as coal, culm, ashes, lime-stone, pottery clay, pipe clay, brick clay, free-stone, fullers' earth, red ochre, slate, and paving stone, can be discovered abundant at one end of the line and deficient at the other; as in the Kennet and Avon Canal, they may be certain that their profits will be great.

III.—The science of geology is of importance to builders, that they may know where to find materials for their purpose, and to the gentleman who means to build himself a house, that he may know where to place it. The skilful geologist, without putting a spade into the ground, can tell where to look for clay, for lime, for building stone, and knows, before-hand, the qualities of each of these important articles. He knows for a certainty where to choose a healthy situation.

For want of this knowledge, how many houses have been deserted after they were built. But, that which is no less valuable, he knows where and at what depth he is to find good water, and where to dig his well.

From a deficiency in this science, gentlemen have put themselves to great expence for little purpose, and have frequently desisted from their undertaking, when they have been within a few feet of water. Thus, for instance, between Hinton and Norton, Farmer Goddard, who had a dipping well, always running, a little to the Eastward of his house; sunk a well in his farm-yard to cut this spring, but, not finding water, even at the depth of sixty feet, he gave over in despair and filled up his well. The spring, he expected to find, is that of the forest marble, and he sought for it in the great oolite. Had he been acquainted with the strata, he would have made up his mind either to go through this rock, under which, on the white clay, he would have had plenty of water, or to bring down by a trough from the dipping well, a sufficient supply of water for his cattle.

In the rising ground, to the Eastward of his house, no fewer than three strata crop out with their several springs; but these all dip the wrong way for him.

To the South-east of this farm at Norton, is a new house built by Mr. Mortimer, and first occupied by Farmer Collier. Here they sunk a well, fifty feet through the bed of sand and got plenty of water, but expecting more at a deeper level, they went through the clay and lost all their water. Nothing then remained but to proceed till they should cut another feeder. This they accomplished, and had no sooner sunk fifty-two feet more, entirely in the forest marble, than the water rose up fifty-five feet in the well, at which level it now stands. Had they been acquainted with the strata, they would have saved this last expence.

In the village of Phillips Norton they meet with a phœnomenon, by which they are exceedingly perplexed, for on one side of the way they have dipping wells, whilst on the opposite side they sink forty-eight feet for water. In the former case they catch the sand springs; in the latter they are obliged to go down for the forest marble springs.

So likewise at Hinton, on the Northern brow of the hill is a dipping well of the forest marble, and a little to the South of this, at the Rose and Crown, the well on the same stratum, is eighteen feet deep, and has never less than twelve feet of water. These are remarkable facts, but easily understood by the geologist.

At Twiverton mill near Bath, a man sunk through the lyas and had plenty of good water, but, doubting whether his supply would continue during the summer months, he cut through the subjacent marl into the red ground and lost all his water.

So it happened at Newton, where Mr. Taylor sunk a well, South of the church, *fifty* feet deep; but, not finding water, he was discouraged, and filled it up again. The next trial was made a little Eastward of the Church, and plenty of water was obtained *under the lyas*, on black marl. But, as this was conceived to be excellent manure, they raised as much of it as possible, to be spread upon the land, touched the subjacent red ground, and lost all their water. Mr. Langton then sunk a hundred feet North-east from the church, *in the red ground;* but, finding no water, he gave over his pursuit. My friend, Jacob Wilkinson, Esq. next tried more to the North, on the hanging of the hill, sunk sixty feet in red ground, and finding no water, he went two hundred yards more to the North, and met with a bed of shingle near the bottom of the hill, where he enjoys plenty of good water. But, as this was found too remote for common use, a well was sunk, in the middle of the village, *seventy-two* feet, through the lyas beds and on the black marl, they found an abundant supply of water, which immediately rose twenty feet, and stands constantly at that height.

To the South of this, in a deep lane at the bottom of the hill, the same lyas beds throw out their springs, and form the dipping well.

To explain the reason of these failures in the first attempts, and of the ultimate success attending these reiterated trials, it may be sufficient to observe, that Newton Church stands on a crop of the lyas beds which yield an abundant supply of water, and which are visibly dislocated and lifted up by the red ground. Consequently, they dip very rapidly to the South; but North of the church there is no lyas. This the geologist would have understood, and would have known, at once, where, and at what depth, he might be certain to find water, and having found it, he never would have lost it by sinking through the marl into the red ground.

A gentleman in Burlington-street in Bath, not being satisfied with the marl springs, formed by filtration, through the bastard freestone, on which his well was sunk, determined to make a trial for some other springs, at what depth soever they might flow. He sunk through the marl and lost his water; but, when by perseverance he had penetrated through the lyas beds, it returned abundantly, and rose up higher than it was before. Had he been acquainted with the strata in his neighbourhood, he would have known before-hand and precisely how deep he had to sink.

The skilful geologist has no need of the *vigula divinatoria* to inform him, where springs are to be found. He knows that they every where exist, and that, to give them vent, he has nothing to do but to perforate either the argillaceous, or the rock stratum, by which they are confined. Or in other words, he is certain, that beneath any given spot, a spring may be created by sinking through the next rock, superincumbent on the stratum of water, which has been filtrated through it, and now flows beneath it. This rock indeed, and its argillaceous covering, may have accidental fissures, through which springs may rise, and in this case, although he should not see them issue, he will know that they are near, by the rushes they produce.

The impostor, with his divining rod, may be perfectly safe in putting his foot upon a spot and saying sink here, and you will find water; because, sink where you please, and, if you sink deep enough, a stratum of water will be found. But he has never yet ventured to say at what depth his springs would issue. This the geologist alone can tell.

IV.—The knowledge of strata is of importance to Commissioners of the turnpike roads, and to Surveyors of the highways, who, for want of it, frequently incur a needless expence in purchasing materials at a distance, when they might obtain the same, or perhaps much better, nearer to the spot where they are wanted. This I have seen repeatedly in the vale of Pewsey. But the most remarkable instance of this occurred about fifty years since, when the great Bath road went through Sandy lane. For here the Commissioners sent ten miles for flints, when to obtain them, their waggons passed the greatest part of the way, over a bed of flints, and when a little knowledge of strata would have taught them, that immediately under the wearisome bed of sand, an abundant supply of ferrugineo-silicious rock might be obtained.

In the same vicinity, at Westbrook and Nonsuch. the stratum of *coral rag* appeared; yet the thickness and value of this remained for ages unexplored, till accident led to the discovery. This valuable rock preserves its course from South West to North East; yet in many parishes, where it is much wanted for lime and for the high ways, it still remains unnoticed and unknown.

Round Bath the Commissioners are ignorant of the strata, and therefore not only repair the roads with detestable materials, but suffer them to be undermined by springs, which might be cut off. This ignorance, however, is not confined to Bath.

In every country I have visited, springs are apt to injure the highways. This may be every where prevented: but then, effectually to cut them off requires attention and a knowledge of the strata. In the new road, which leads from Bath to Bradford, the springs have proved exceedingly detrimental; but had the Commissioners understood the nature of the strata, through which the road is cut, they might, with the utmost facility, have cut off these springs, and thereby have prevented the slides, by which this road both suffers much, and is, in rainy seasons, threatened with destruction.

V.—*Brick makers* are often at a loss for proper clay to make such goods as the market may require; yet, as every bed of clay has its attendant rock, so every rock has its attendant bed of clay.

From every part of the kingdom refiners and the managers of smelting houses sent to Stourbridge for their bricks; but now they are grown wiser, and seek them nearer home, and it is at last discovered, that the same kind of clay is every where subjacent to the coal.

VI.—So likewise *statuaries* and *marble masons* sent to Paris for their plaister; and it was conceived, that this valuable article was no where else to be procured. In vain did Plymouth rocks present their gypsum to the artist, till the bounds of science were enlarged.

VII.—*Fullers' earth* is an article of prime necessity in the manufacturing of cloth. This was conceived to be so peculiarly the produce of England, that it was made felony, by an Act of Parliament, to export it, even into Ireland or into Scotland. And at the present day, the clothiers of Wilts procure it from Somersetshire, at a considerable expence. At Bradford this is the more remarkable, because the surrounding hills abound with it, although the clothiers know not where to look for it. In many other parts of England, this treasure lies concealed for want of knowledge.

VIII.—The knowledge of geology is of importance to *coal adventurers*, that they may neither deceive themselves in their expectations, nor become a prey to designing men, who may endeavour to deceive them. Near Titherington, at a high level above the Kelloway rock, Sir Edward Baynton was prevailed upon to try for coal. Here he was amused and flattered with the hope of an extensive colliery, and from time to time the workmen shewed him indubitable signs of coal, till the subscription funds and his patience were exhausted, and then they reluctantly departed. In like manner some ignorant people were prevailed upon, at great expence, to try for coal on Road Common, about ten miles to the South of Bath, where the cornbrash rock is found.

The most wild and expensive trial for coal I ever heard of, was, if I am rightly informed, by Sir John Webb, on Canford-heath, near Pool, in Dorsetshire, where he bored two hundred and eighty feet in chalk, and spent, as the engineer assured me, near fifteen thousand pounds, without a possibility of attaining the object of his pursuit.

I understand, that a similar trial, with similar success, has been made near Horsham in Sussex.

Numerous other trials, equally, or more absurb, have been projected; and many have been made in Great Britain, France, Spain, Italy, and even in America, which a knowledge of geology would have prevented.

From what I have stated respecting the thickness of the several rock strata, in our island, it will appear, that the whole depth from the summit of the chalk hills to coal, inclusive of the clay beds, must be at least six hundred yards; in sinking down to which, twelve strata of water must be cut. At Sir Edward Baynton's trial for coal near Titherington, the depth must have been very considerably more than three hundred yards, with seven strata of water. From the top of the great oolite to coal, must be at least two hundred and forty yards, with four strata of water. And from the top of the lyas, wherever all its beds are found, we may safely reckon more than ninety yards to coal. At Newton near Bath, the coal is sixty yards deep. At Kingswood, they have sunk their coal pits two hundred and forty yards, and at Newcastle four hundred.

The disadvantages attendant on new trials are very great. Should the pits happen to be sunk on the mountain lime-stone, all the expence of sinking them will be lost. Should they be sunk on a trap or fault, the adventurers will be wholly in the dark, and may sink till they are weary, without finding coal. Or should they chance to meet with a tract of country where faults abound, they may spend their money, but they will make no return.

Even in districts which have been explored, the risk is great.

When my father, under a grant from Lord Mansel, was working the famous Llanwern vein, near Swansea, he met with a fault, which cut off the coal. He drove through this, and sunk, but in vain.—He made a second drift, near twenty fathom deeper than the former, went through the fault, and bored seventeen fathom, but in vain. He then sunk a new pit sixty fathom, and drove through the fault again, but all in vain, till at the end of near thirty years, and at the depth of four-score fathom, after having expended more than thirty thousand pounds in the pursuit, he had the satisfaction of knowing that he had found the vein. He had indeed made the important discovery, but even then the work was but just begun, for though he had found the vein, he found it only by the borer, and pits were to be sunk; after which a canal was to be dug for the conveyance of the coal to the sea side: insomuch that the whole expense, before any kind of return was made, could not be estimated at less than one hundred thousand pounds. In this case, the issue was in some measure fortunate; but numerous instances might be produced, in which the whole sum adventured has been lost. It is the science of geology alone which can enable the coal adventurer, in the first instance, to form a rational speculation, and in the second place to estimate the risk he runs.

IX.—A knowledge of geology is of vast importance to mineral adventurers, who without it may be ruined, and by its acquisition, may increase in wealth. The instances I have adduced of deluded hopes, and of fortunes rapidly acquired, by the ignorance or skill of miners, when I was treating of dislocations, are sufficient to evince the truth of my remark. Had the unsuccessful been acquainted with geology, they would not have lost their labor, and left behind them unexplored such treasure for better-instructed or more fortunate adventurers.

On this subject the most able performance has been long in our possession. I mean *Agricola* de re Metallica, a work which can never be too familiar to those who venture their money in deep mines.

X.—The science of geology becomes of infinite importance, when we consider it as connected with our immortal hopes. These depend on the truth of revelation, and the whole system of revealed religion is ultimately connected with the veracity of Moses.

The divine legation of Christ and of the Jewish Lawgiver must stand or fall together. If the Mosaic account of the creation and of the deluge is true, and consequently the promises recorded by him well founded, we may retain our hopes; but, should the former be given up as false, we must renounce the latter.

It has been objected to his account of the deluge, that had the whole atmosphere been converted into rain, it could have raised the water only thirty feet, the height to which a column of water can be raised by the pressure of the atmosphere. This therefore would not have been sufficient to reach the summits of our most moderate hills.—Mathematicians have even calculated with much labor how many oceans of water would be required to cover the tops of our most lofty mountains, and have perplexed themselves with difficulties of their own creating. But when we consider that the fountains of the great deep were broken up, and that the ocean poured its whole contents upon the earth, it must be clear to us, that a sufficient quantity of water could not be wanting for the destruction of a guilty world.

The description of Moses, short as it is, corresponds exactly with the phœnomena produced by this grand convulsion. The accounts we have received of volcanic eruptions, exhibit a deluge in miniature, with its occasional causes and consequent effects. These are commonly attended by incessant rain; the fountains of the great deep are broken up; the waters overflow; and in their retreat they have been observed *going* and *returning* by alternations, as particularly noticed at Kingston, in Jamaica, at Callao, and more recently at Lisbon. This part of the subject has been so skilfully handled by Whitehurst, that subsequent writers can do little more than copy his judicious observations. I shall therefor content myself with having demonstrated by a reference to facts, that the earth has been overwhelmed by an universal deluge.

Some vain pretenders to science, have been ambitious to display their knowledge and sagacity, by an appeal to natural evidence for the antiquity of the present system, in opposition to the Chronology of Moses. This evidence they have endeavoured to produce from the numerous beds of vegetable earth interposed between the several eruptions of Ætna and Vesuvius. The most distinguished hero in this field of infidelity, was the Cannon Recupero, and his idle observations have been recorded by a traveller of no mean talents in composition, although ill qualified to estimate the value of an opinion, which he has thought proper to communicate.

It is well known, that the materials ejected by volcanoes, at various intervals, are extremely various; some, being apt to moulder, are readily decomposed and quickly converted into soil, whilst other substances are so refractory, as to remain unchanged for ages, and others again remain for ever barren.

There is no vestige of vegetable earth over the whole of Mount Castagna, and very little in Campo Blanco, although their origin was anterior to all our records. The lava of Ætna ejected, A. D. 1329, was covered eight inches with earth before the year 1776—that of Ischia, which issued in 1302, had produced no vegetable earth at the end of the last century. Even to the present day it continues to preserve its hardness and sterility. Another current of lava in Catania, at the end of two thousand years remains precisely in the same condition.* No fewer than six alterations of lava and of volcanic ashes, which immediately admit of vegetation, appear over Herculaneum, the destruction of which is recent.

When I was travelling in Arragon, I remarked, that in a whole day's journey no trace of vegetable soil was to be seen.

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* Spalanzani's Two Sicilies tom. 8vo. 1798.

In addition to what I have said upon this subject, I must here repeat an observation already made, that from chalk, through all the intermediate strata incumbent on the granite, in all our perforations, no vestige of vegetable soil is to be seen, excepting on the surface of the earth.

Our infidel traveller is mistaken, not merely in the application of his rule, but in the rule itself. His hypothesis was idle, and his application of that hypothesis absurd.

It remains therefore as a fact, that we have *one* bed of vegetable earth, formed by the hand of time, since the grand convulsion which turned the dry land into barrenness, and the bed of the ocean into a fertile field.

It has been a favorite notion with a certain description of philosophers, that the ocean is progressively shifting its bed, retreating in one direction and advancing in the other; swallowing up old continents, whilst others are incessantly protruded from beneath its waves.

These distinguished sages, however, do not agree.

Buffon, because it happened to suit his system, conceived, that the sea is moving from East to West, gaining on the Eastern coasts, and losing on the Western.

Professor Link, on the contrary, persuades himself that the sea strives unremittingly to extend its dominion from West to East.

Unfortunately for the credit of these wise men, all our most elevated mountains in every part of the earth, have respectively the same dates. Granite in the Alps, Andes, and Tartarian mountains, consists of quartz, field spar, and mica. The superincumbent sand-stone is disintigrated granite. The attendant lime-stone is uniformly composed of the spoils of zoophytes, of encrinus, and of corals, with certain species of anomiæ. All other rock strata are characterized by their distinctive fossils. Coal beds, throughout the globe, are found only in the neighbourhood of the mountain lime-stone. Chalk is every where the same substance, and preserves its situation with respect to other strata. The detritus of all these constitutes our soil, and this, with the spoils of animals and vegetables, forms our vegetable earth, which, like the rock strata, every where in Europe, Asia, Africa, and America, refers us to one date.

Where then has nature been detected in producing these substances, or any one of them?

Supposing her operations in their formation, and in bringing them to light to have been constant and progressive; such successive operations could not have escaped the observation of mankind. Our records, from early ages, would have noticed the rise and progress of new granitic peaks; new mountains of lime-stone, containing different species of marine productions, would have made their appearance in the ocean, and the natural history of both chalk and flints could not be, as they are at present, hid from us.

The statement of De Luc respecting the church of St. Marc, in Venice, and of the cathedral in the Isle of Torcello, with the concession of Dr. Hutton, in regard to the port of Byzantium, and the Isthmus of Corinth, being the same as they were two or three thousand years ago; these things prove, that the hypothesis, above referred to, is inconsistent with acknowledged facts.

But could we even grant, that the ocean is constantly robbing the continents in one direction, and depositing their spoils in the opposite direction, whether East or West, this would not account for the dip of strata from the high granitic chains.

From the observation, that the bones of elephants and of other animals, inhabitants of the torrid zone, have been discovered in high Northern latitudes, philosophers have hastily concluded, that the earth has been regularly and incessantly shifting her poles, and changing her climates. In fact the teeth, tusks, and bones of the Asiatic elephant and of the mammouth, have been found in the wide expanse of mountains from 50°. North latitude to as many South, that is, from the Ohio to Patagonia.

But then it must be observed, that the ivory in all these teeth and tusks, so widely scattered over distant climates, refers us nearly to the same date, and that date not more remote than numerous other facts enable us to fix on, as the epoch of the universal deluge. The ivory is so well preserved as to be fit for use; those spoils of terrene animals are discovered in alluvial strata, and with them we find, as at Walton in Essex, shells, fish-bones, and other productions of the ocean.

We are informed, that in Siberia, Professor Pallas met with the carcase of a rhinoceros, which still retained in part the skin and hair unchanged.

Now had this and other animals of a warm climate died on the spot, where these carcases appear, and had the temperature been gradually and slowly changed from heat to cold; the whole corruptible substance would have submitted to the laws of nature, and must have either perished by putrifaction or been devoured by worms. But, when, at the grand convulsion, such a perishable substance had been conveyed into the frigid zone; it there remained and will remain unchanged.

It is remarkable, that in the Ural mountains the bones of the mammouth are confined to the alluvial strata, and appear chiefly in the elevated tract of country watered by rivers, which fall into the Tobol, and the Obi. Some few indeed appear near Lake Ischernoi, whose waters ultimately flow into the Volga. But this lake is nearly contiguous to the river Tagil, which falls into the Toura, as that does into the Tobol. The district in which they have been noticed, is one of the most lofty portions of Siberia, and the source of its great rivers, whether flowing towards the Caspian to the South, or towards the Frozen Ocean to the North.

Thus have I demonstrated, that the Mosaic account of the Deluge, does not merely accord with traditional reports universally diffused through civilized and savage nations; but is confirmed by infallible records inscribed on our Alpine rocks, and legible on all the strata, discovered by our deepest excavations in the bowels of the earth.

The veracity of Moses, as an historian, stands therefore unimpeached by the natural evidence to be derived from the actual condition of our globe.

In my next work, should I live to finish it, I shall examine the languages, customs and manners of the human race, as described in the Pentateuch, and in the most venerable records of the Pagan World.

FINIS.

EXTRANEOUS FOSSILS.

My object in this part of my work is to enable my readers, by means of extraneous fossils, to distinguish the several strata of our island. For this purpose I have made accurate designs of my own fossils, arranged according to the strata from which they were collected, and, were it possible, I would in every instance refer to the Systema Naturæ, as being in every one's possession; but to class extraneous bivalves according to the Linnæan system, is most often difficult, and frequently impossible, because we can seldom see the hinge, and never determine what has been the colour. Without the first of these we cannot ascertain the genus: without the latter, it is not always possible to fix the species.

But in addition to these impediments it must be observed, that, as in the recent state, many genera and species exist, which are not found fossil; so, many fossil shells have been discovered, which have no analogues among the recent shells, with which we are acquainted.

In these circumstances the best expedient is, to give the exact representation of the fossil, with the place where it appears, and a reference to the works of our best naturalists, such as Woodward, Lhwyd, Morton, Knorr, Plott, and Parkinson.

This I shall attempt, and, should I fail to answer the expectations of my readers, they will, I hope, attribute this failure to any other cause rather than to want of diligent attention.—It must be observed that all my figures are of the same size with the originals.

I have not here introduced *chalk* fossils, because, having few in my possession, and these few being such only as are extremely common, they are not worrthy of particular description, more especially because the chalk stratum is sufficiently evident without them.

My three first plates contain the most remarkable fossils of that *green sand* bed, which is immediately beneath the chalk.

DESCRIPTION OF THE PLATES.

PLATE I.

Fig. 1. Represents one of the nodules, which abound in this bed, at least in the Vale of Pewsey. These commonly contain some extraneous body, and most frequently either a perfect cup or some fragment of a cup. One of the former has been selected by Mr. Parkinson, for the frontispiece of the Second Volume of his Organic Remains. Shall we call this alcyonium? Is it madrepora? Is it a sponge? I have many specimens of these cups, which have been compressed, and others which have their margin folded back without being fractured. On the other hand, I have numbers which are evidently fractured, and have sharp edges. The former I conceive to be sponges of the infundibuliform species. The latter I am persuaded are cup corals. Such were the corals of M. Guettard, as appears by the Memoirs of the Academy of Paris, for the year 1751. His seventh plate contains four cups which resemble mine, with this difference, that, in the extremity, each of his stems appears rounded at the edges, whilst mine are universally sharp.

2. A. is the ostrea muricata, which is figured in Gualtieri, tabula 73. f. 1. Fig. 2. B. is a different view of the same. Specimens of this shell abound in the green sand, and are most interesting on account of the acuteness of their murices, which distinctly prove, that they have never been subject to attrition. 2. C. represents these magnified.

3. Is a mytilus crista galli.

PLATE II.

Fossils of the Green Sand continued.

Fig. 1. Is a zoophyte, but whether lithophyte or sponge is not sufficiently clear. The cup is very remarkably incurvated on one side, and bent downwards without being fractured: yet the other discovers fracture. It was inclosed in a green sand nodule, precisely like fig. 1. of plate 1. No part was visible excepting the termination of the stem, which protruded, and whose edge was sharp.

2. Resembles the preceding, with the addition of specks
3. Belongs to some genus of zoophyte. All I can say of it is, that the representation is accurate. These were found at Pewsey.
4. Is an echinite, from Long Leat, where it is found in great abundance.
5. Is a beautiful anomia, from ditto.

PLATE III.

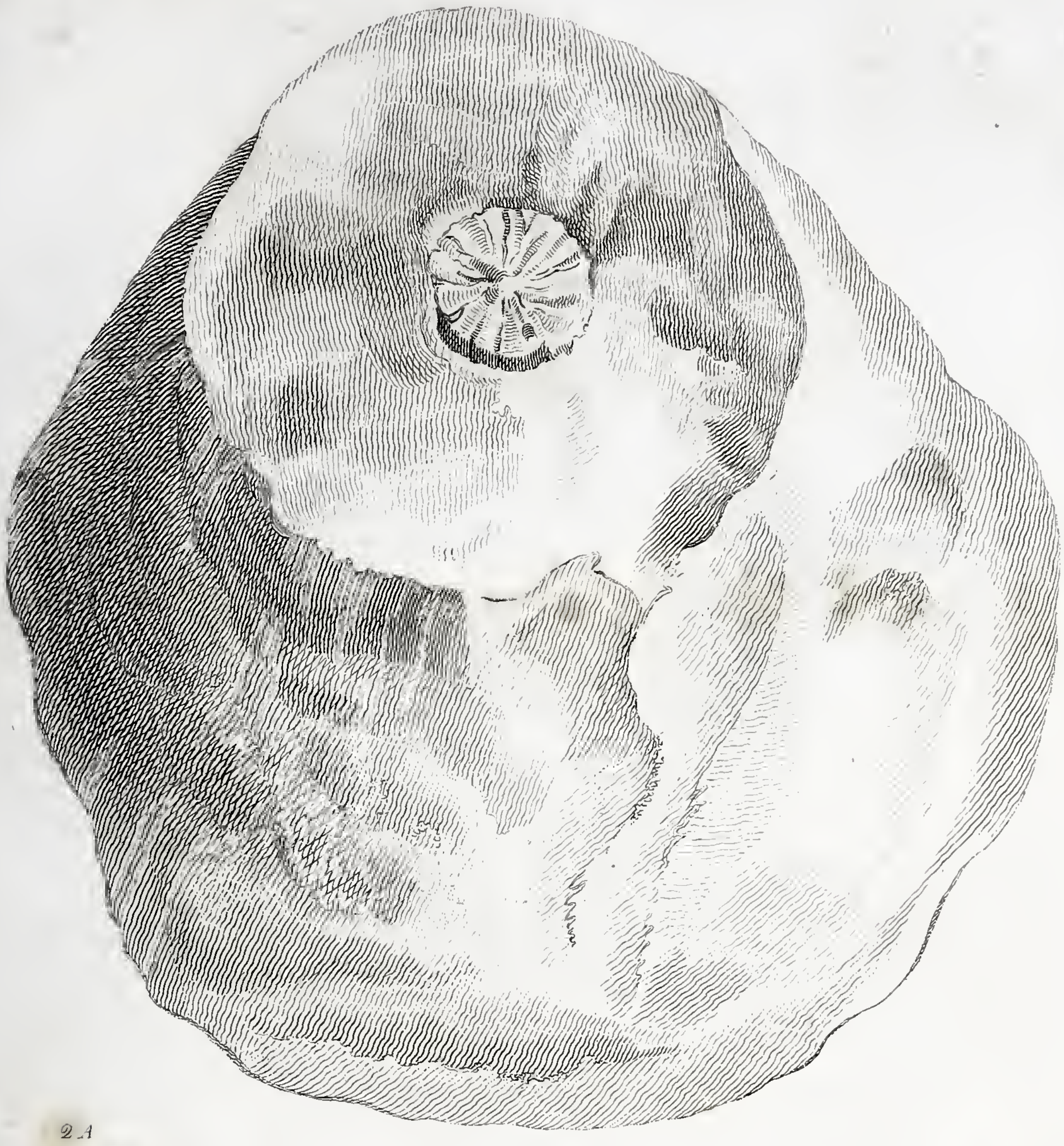
Fossils of the Green Sand continued.

Fig. 1. Has some resemblance in form to the fossil selected by Mr. Parkinson, for the frontispiece of his 2d volume. My cup, however, is much smaller than his, the stem is longer in proportion to the cup, and the pedicle does not expand itself like his.

2 }
3 } Must answer for themselves. These were all completely hid in nodules of green sand, which, in the interior, are somewhat agatized.

PLATE I.

1



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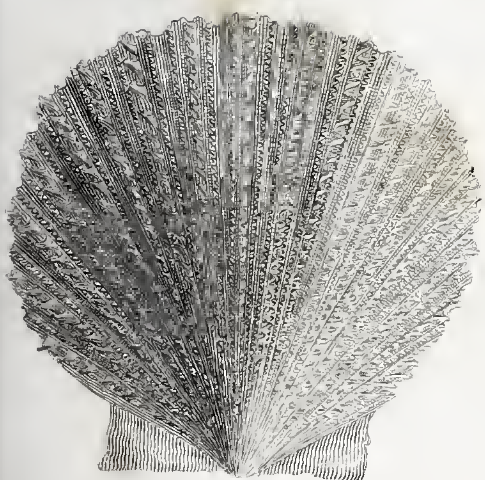

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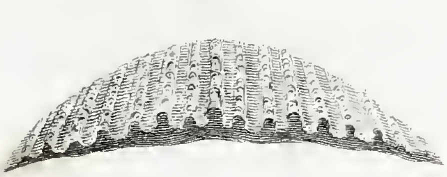

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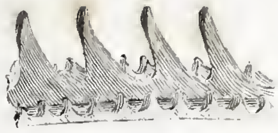

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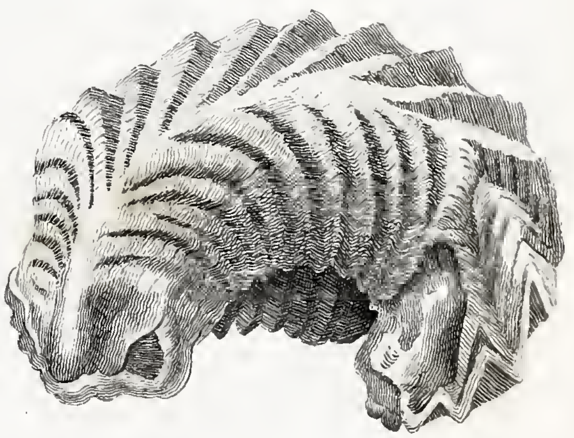

Rev.d Jos.h Townsend delin   Bart Howlett sculp

London Published as the Act directs July 1, 1812, for The Rev.d Joseph Townsend, Pewsey

PLATE II.

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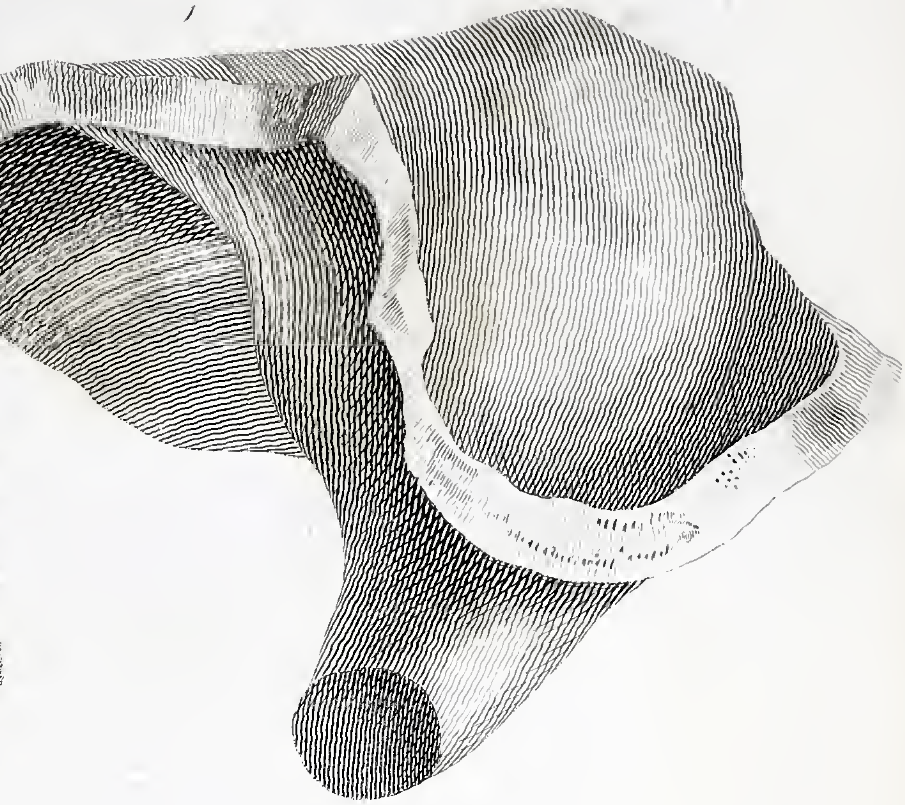

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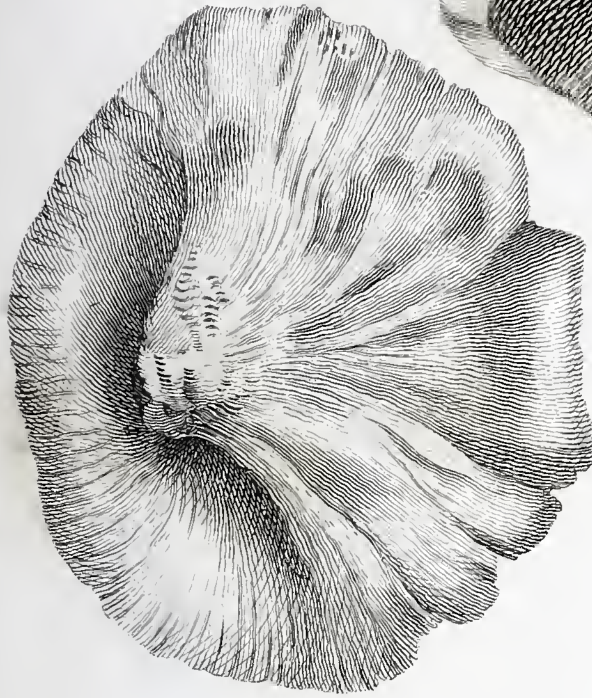

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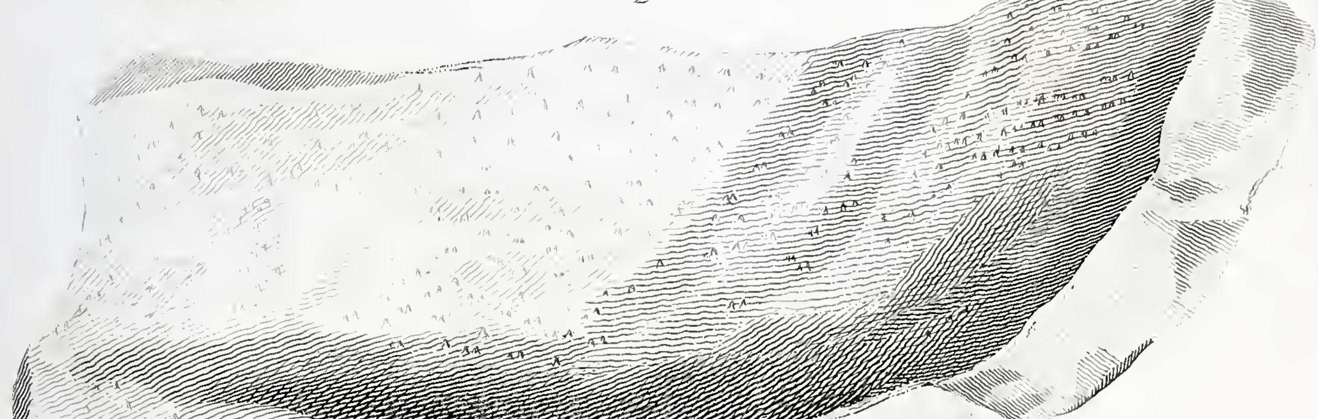

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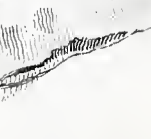

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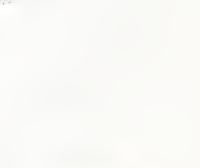
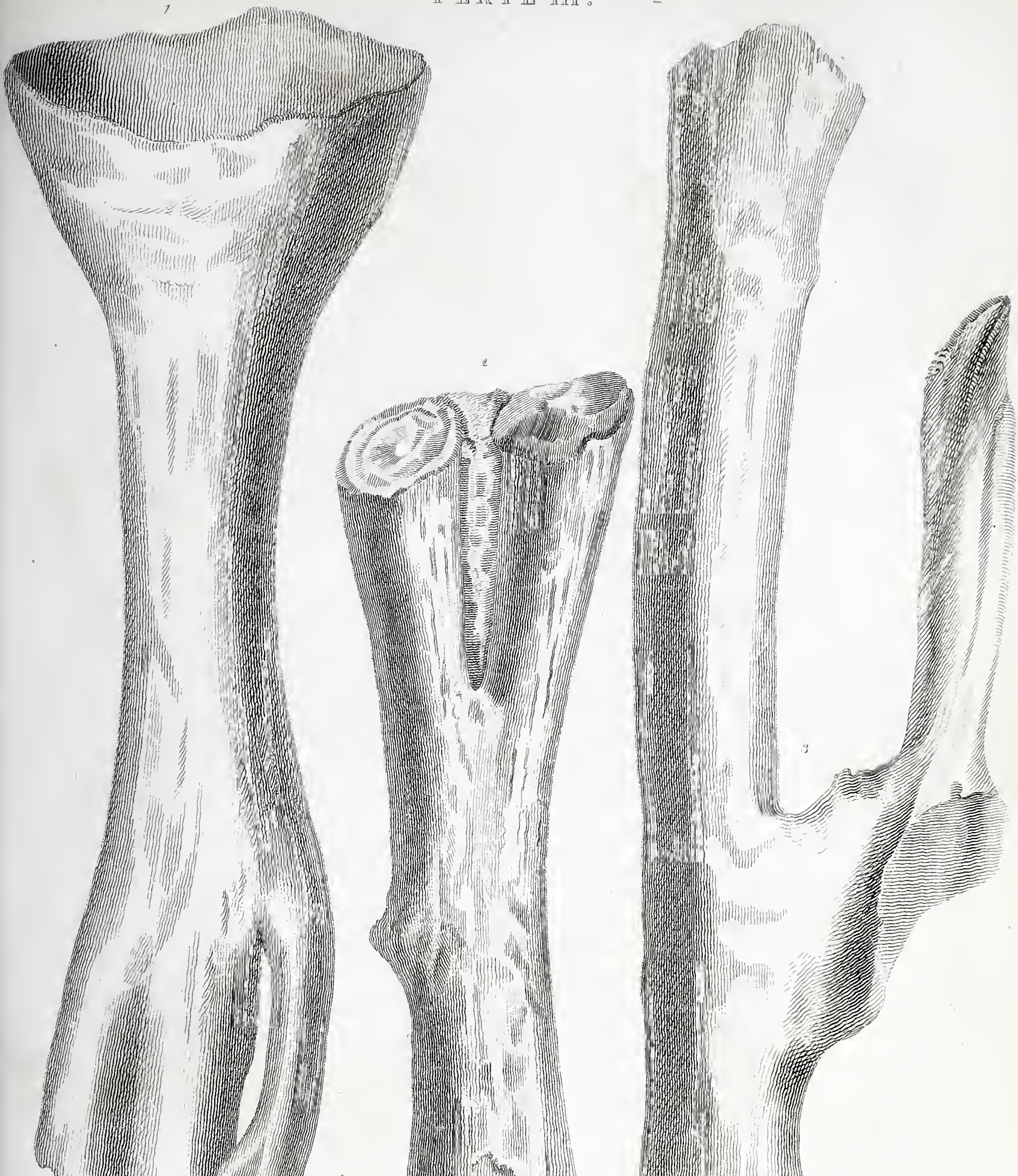


Rev.d Jos.h Townsend delin

Bart.w Howlett sculp

London Published as the Act directs July 1, 1812 for The Rev.d Joseph Townsend, Pewsey

PLATE III.



Revd. Josh. Townsend delin

Bartw. Howlett sculp

London Published as the Act directs July 1 1812 for The Rev Joseph Townsend, Pewsey.

PLATE IV

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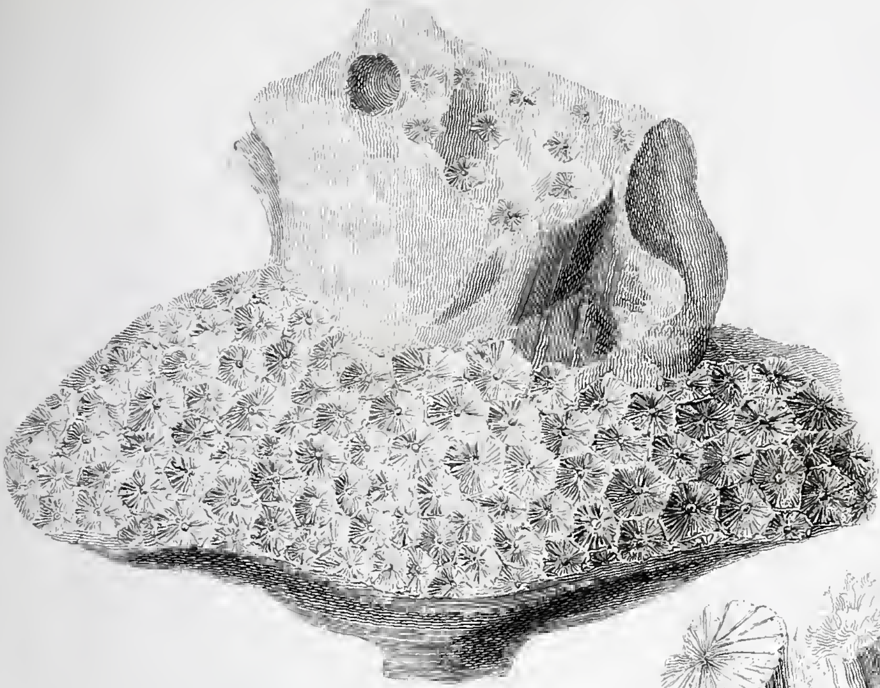

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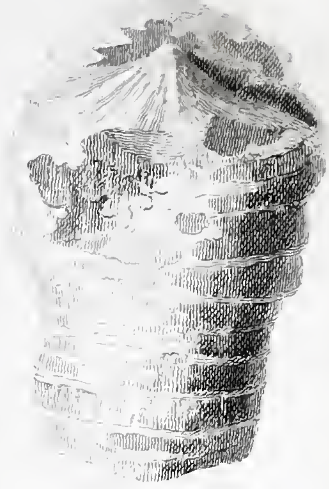

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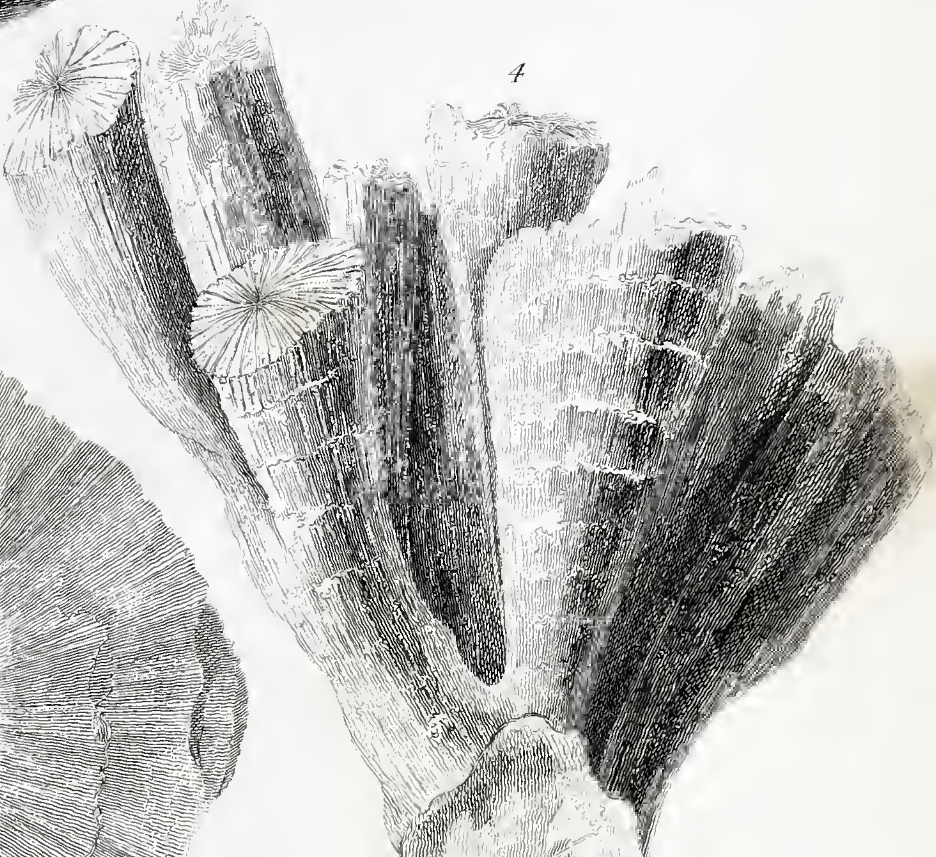

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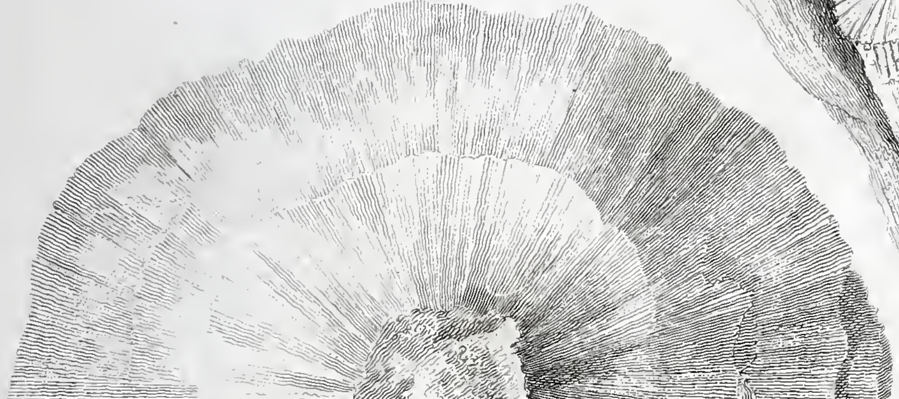
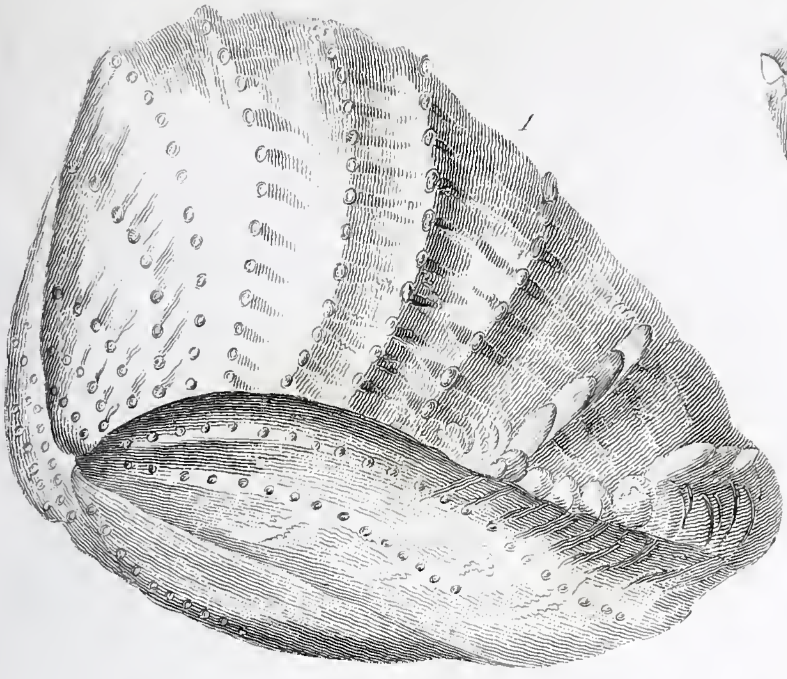


Revd Josh Townsend del

Burt w. Howlett sculp.

London Published as the Act directs July 1,1812 for The Revd Joseph Townsend, Pewsey.

PLATE V.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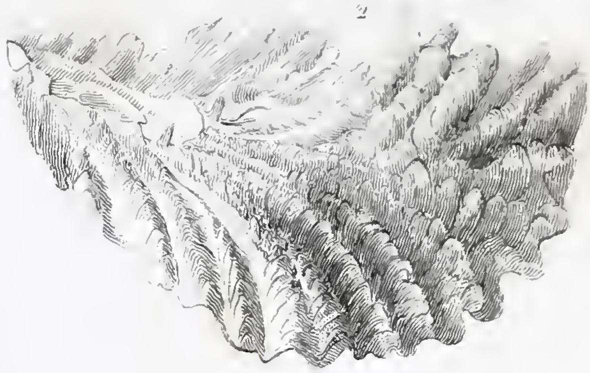
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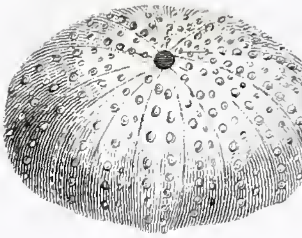
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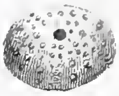
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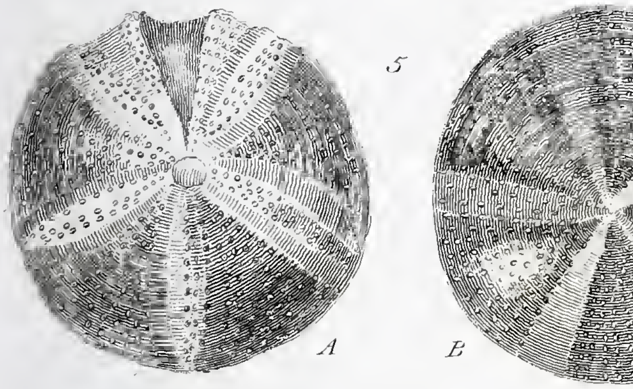
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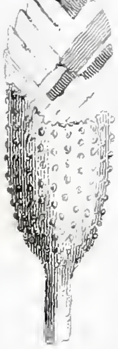
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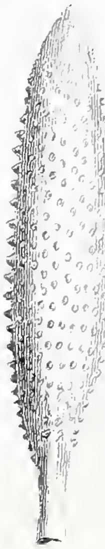
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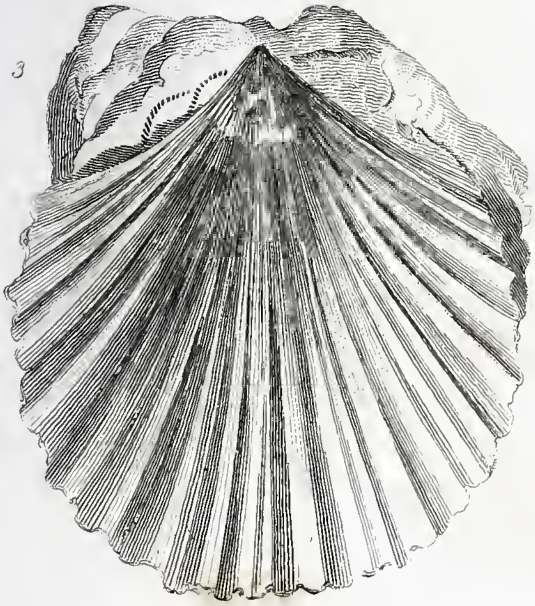
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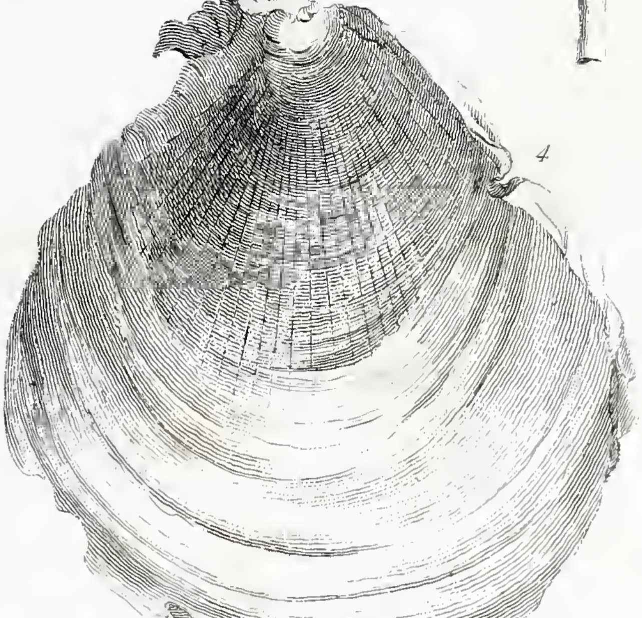
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PLATE IV.

Fossils of the Coral Rag Rock.

Fig. 1. and 2. Represent different views of a Stellated Madreporite from Steeple Ashton. The first shews how Madreporæ of this species increase: the second exhibits the under part with its stem broken off. It is found recent in the seas which surround Amboyna.

3. Is a madreporite from Shotover. It is figured by Plott.

4. Is a madreporite from Steeple Ashton, of which each stem is divided into three, and every one of these becomes again subdivided in like manner. It is a native of the South American Seas. A recent specimen may be seen at Bristol, in the superb collection of W. Broderip, Esq.

PLATE V.

Fossils of the Coral Rag continued.

Fig. 1. Is trigonia clavellata of Parkinson, commonly known by the name of studded cuneus. It is found at Westbrook, near Calne.

2. Is mytilus crista galli of Linnæus. It is recent in the red sea and Indian ocean.

3. Is called by Morton, pecten tenuis maculosus.

4. Is pectinites amphiotis inferius rugosus of Morton and of Lhwyd.

5---9. Are well figured by Plott. He found them near Oxford. I obtained them formerly in great abundance from Quemerford Common and the stone pits north of Calne. They are imbedded in blue marl, and neither the echinites nor their spines are even in the least degree abraded. The spines, although extremely brittle, are very seldom broken in their bed. One specimen of the mammillated echinite with the spines, here described, all perfect and recumbent by its side, was nearly forty-seven years since, sold by auction in London for seven guineas. It came from Calne, and was the property of one Eatwell, a Blacksmith there.

PLATE VI.

Fossils of the Coral Rag continued as far as No. 15.

Fig. 1. and 2. Are figured by Morton; the former he calls a pectinites, the latter pectunculites.
3. to 15. Are from Plott's Oxfordshire.
16.---22. Are from Quemerford common. These belong to the superior Oolite.
23. Is the spine of an echinite, and many such are found recumbent near to the echinites, from which they seem to have fallen.
24. Is cochlites levis vulgatior of Lhwyd.

PLATE VII.

Ammonites from the Kelloway rock, the figures of which are adopted from Morton.

PLATE VIII.

Fossils of the Kelloway Rock continued.

Fig. 1. 2. 3. Are from Morton.
4. and 5. Are terebratula and sacculus of Lhwyd.
6. Is mytiloides longiusculus angustior of Lhwyd.
7. and 8. Are different views of the concave valves of an oyster distinguished by the name of lobate oyster.
9. Is the upper valve of the same oyster.

PLATE VI.

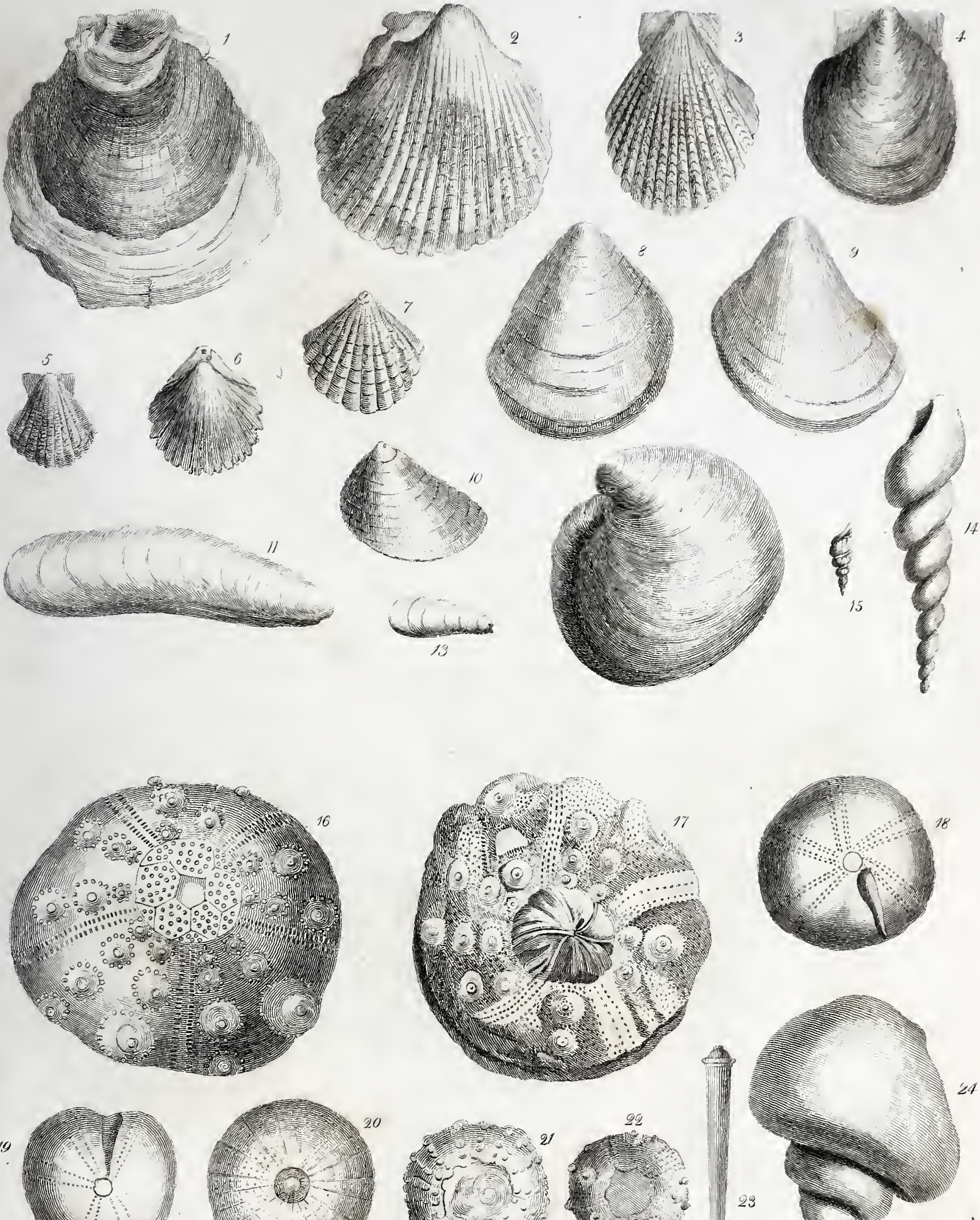

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PLATE VII.

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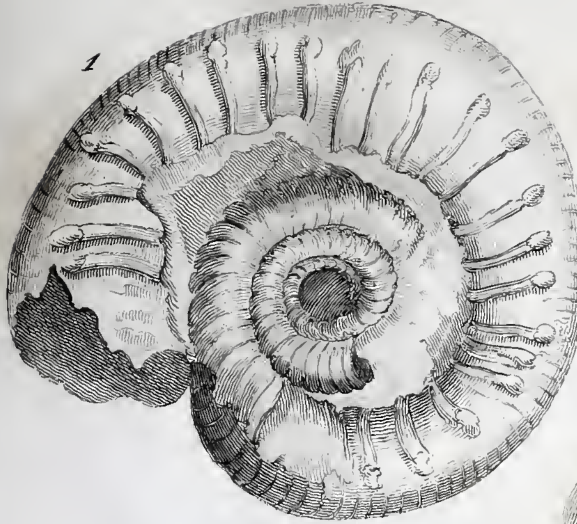

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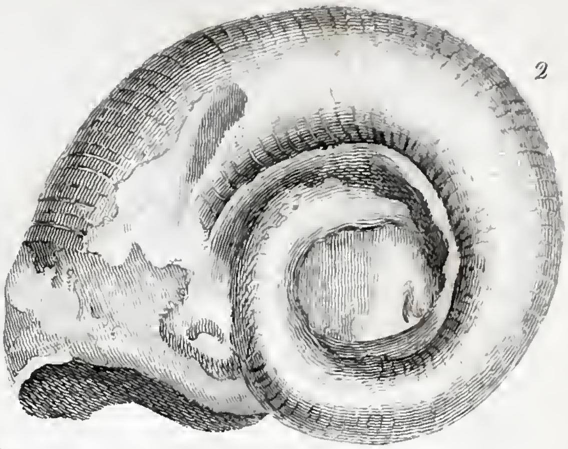

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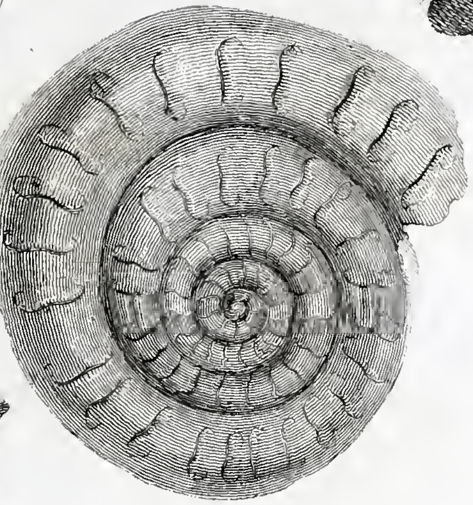

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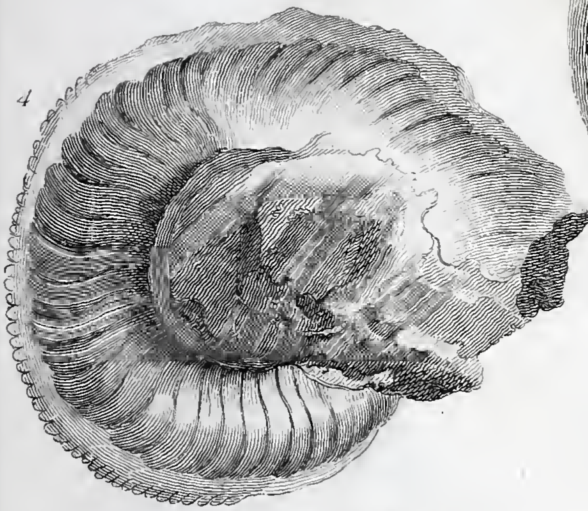

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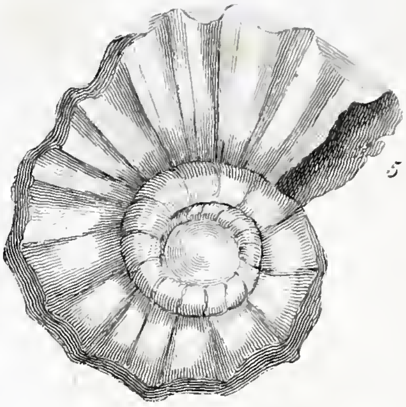

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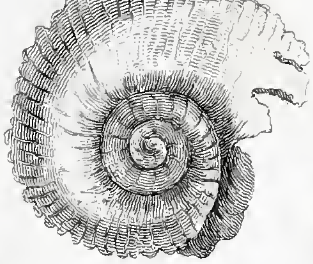

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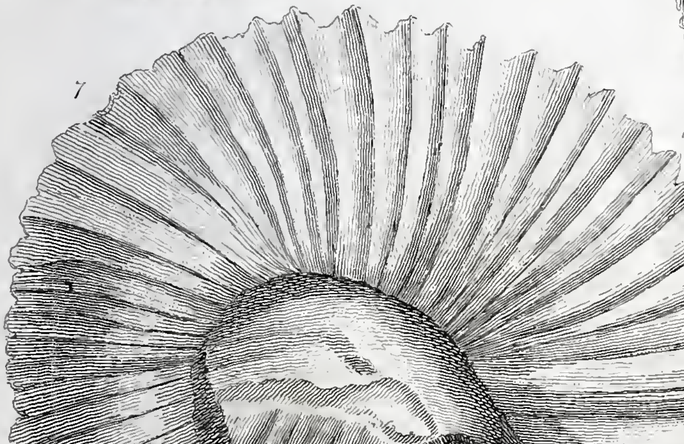

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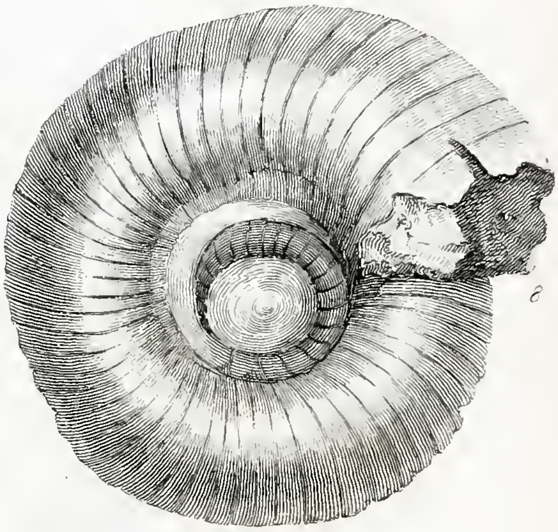

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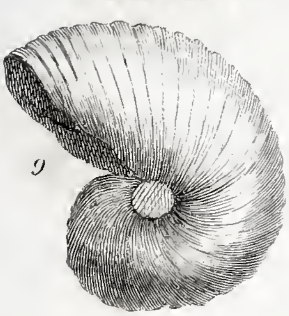

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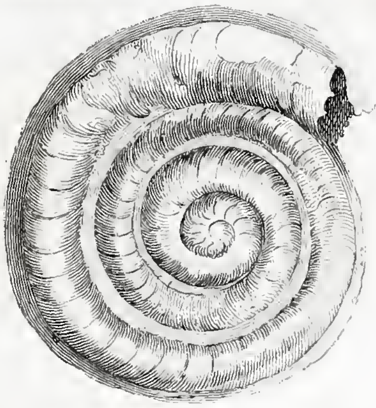

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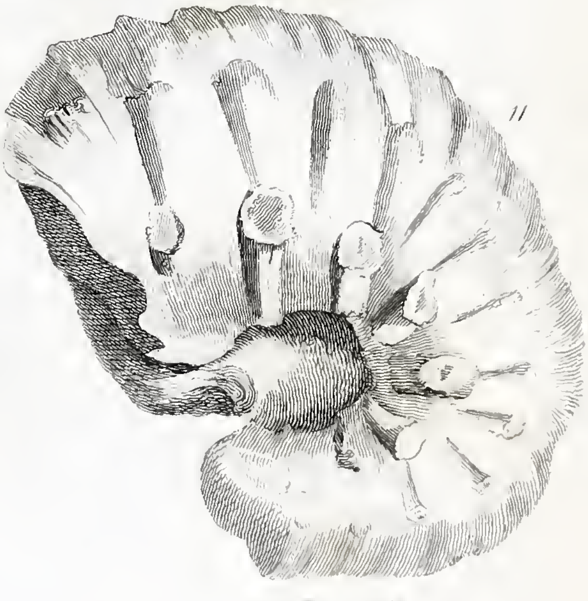

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PLATE VIII.

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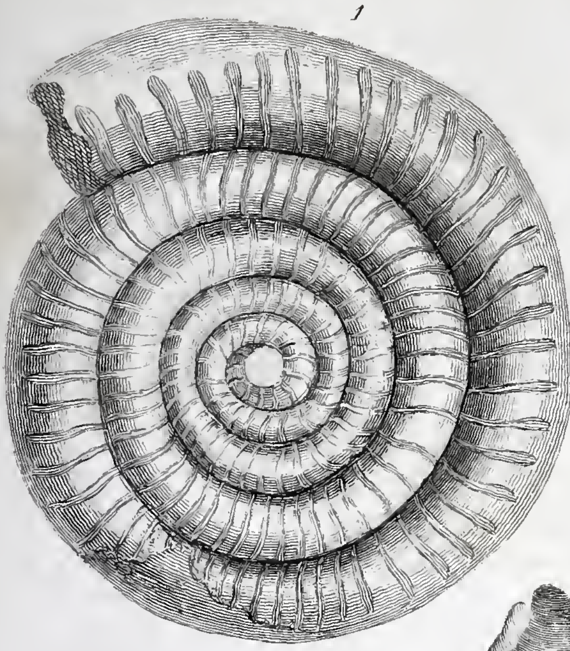

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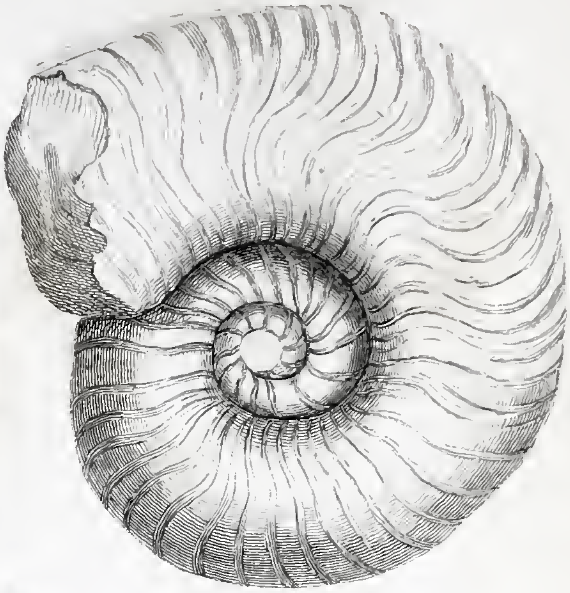

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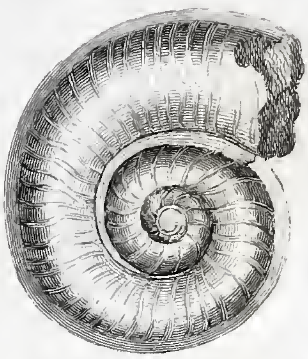

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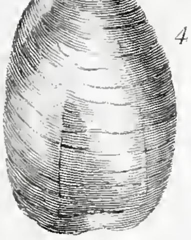

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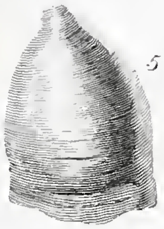

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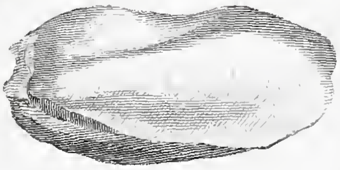

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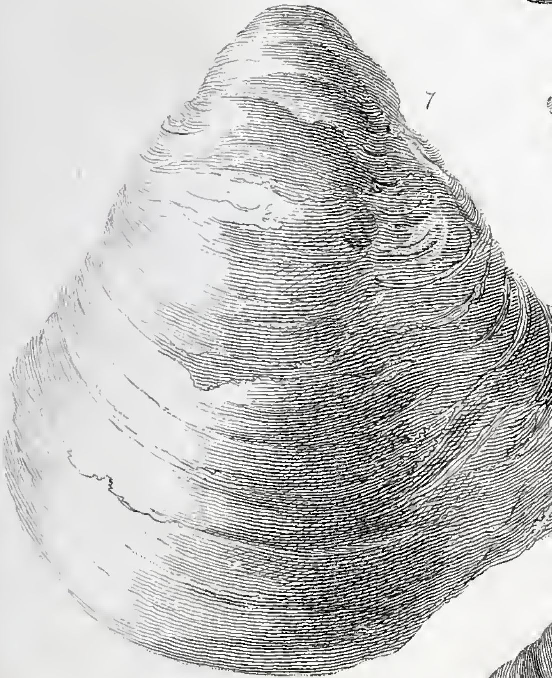

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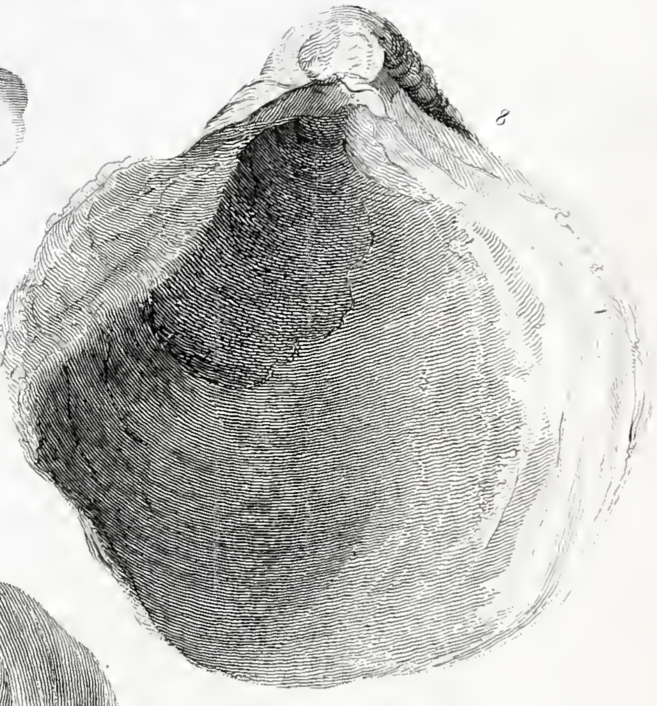

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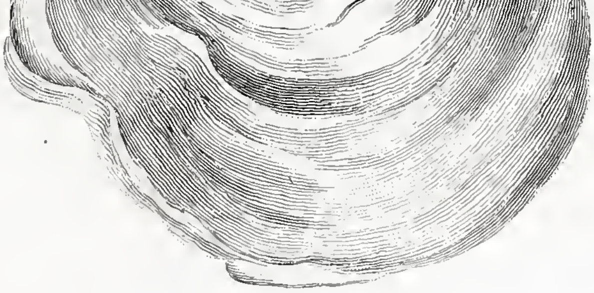

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PLATE IX.

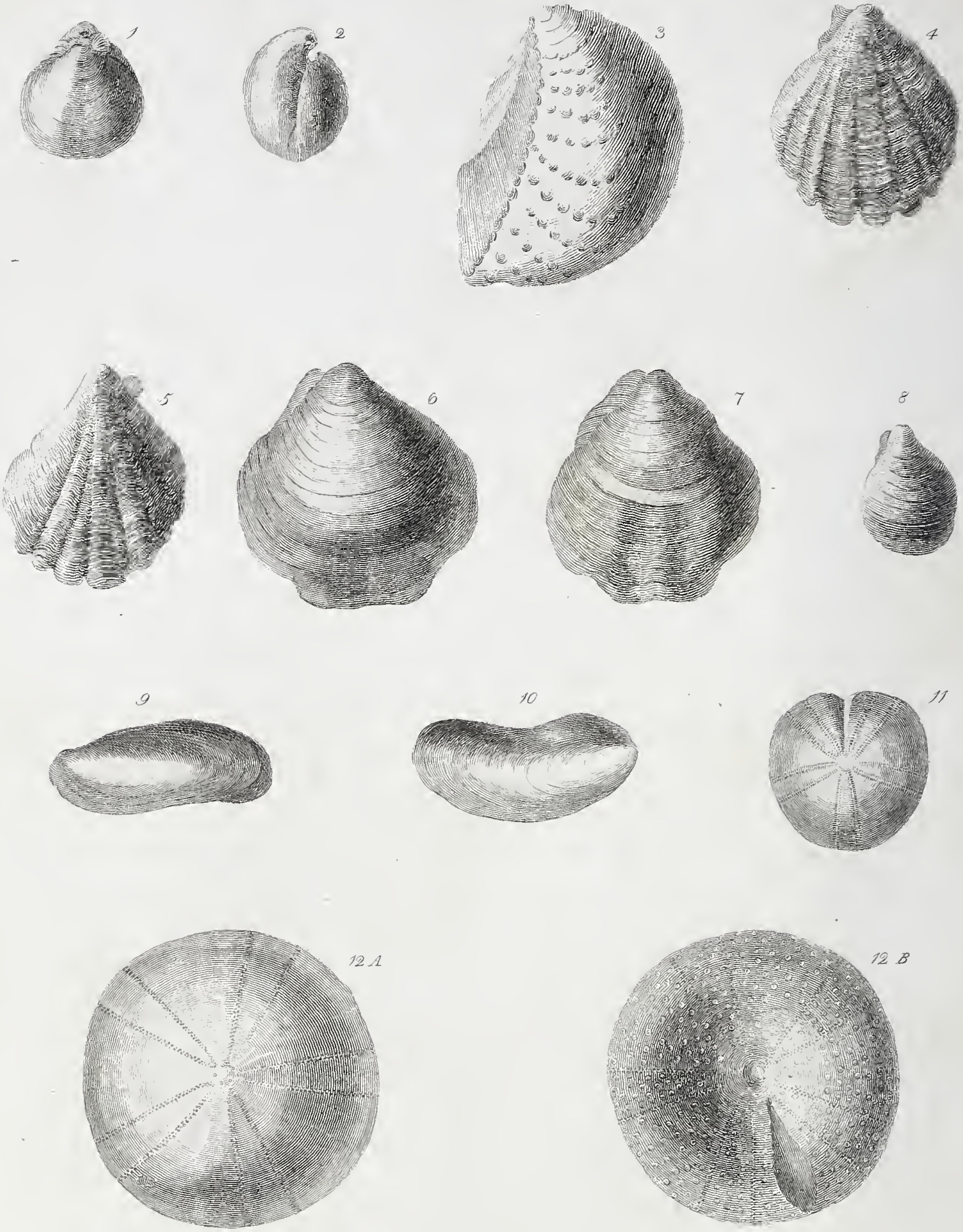

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PLATE X.

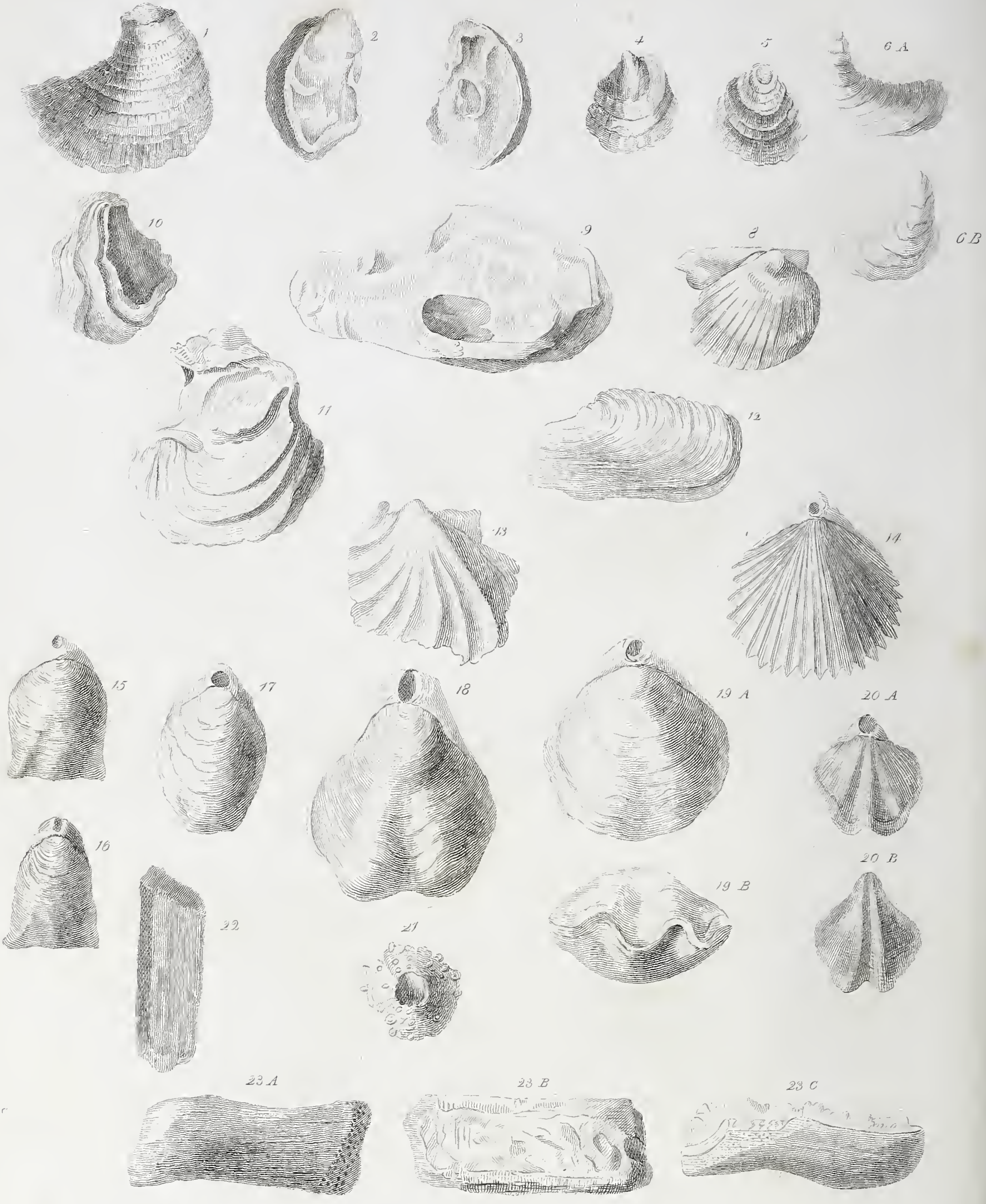

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PLATE IX.

Fossils of the Cornbrash.

Fig. 1. and 2. Are different views of the anomia, which principally characterizes this rock.
3. Is a studded cuneus, trigonia clavellata of Parkinson, from Chatley.
4, and 5. Are oysters from Chatley.
6. Is a species of anomia from Sherborne.
7. Ditto from Bruham.
8. Is terebratula capsularia of Lhwyd from Woolverton.
9. and 10. Are different views of mytilus modiolus.
11. and 12. Are echinites from Chatley.

PLATE X.

Fossils of the great Oolite.

We have here six species of ostreum, two of mytilus and seven of anomia. Among the latter, we find anomia saccus. A. 16, of Lister, 456. Anomia caput serpentis, anomia terebratula, anomia plicatella, and anomia reticularis of Linnæus. These have not as yet been discovered in a recent state.

Among the ostrea, Fig. 1. is ostreum minus falcatum of Lhwyd.

Fig. 4. and 5. Represent ostracites operculo externe concavo et aculeato of the same author.
13. Is a mytilus, and, as the form must determine the species, I have ventured to call it mytilus costatus.
17. Anomia caput serpentis.
18. Is anomia terebratula.
19. A. 19. B. Are two views of anomia terebratula.
20. A. 20. B. Represent different views of anomia reticularis.
21. An echinite from Bradford.
22. A siliquastrum from Northamptonshire.
23. A. B. and C. are several views of a siliquastrum to shew the enamel and the alveolar process of the tooth. This came from near Wraxal.

PLATE XI.

Fossils of the great Oolite continued.

Fig. 1.---4. Are asteria of Northamptonshire.
5. Is the astropodium imbricatum bifidum of Lhwyd. These evidently differ from our Bradford fossil. The former belong to pentacrinites.
6.---14. Exhibit different parts of the pelvis and body of the pear encrinite of Bradford.
15. Is a section of figure 10. These in addition to the figures of Mr. Parkinson in the sixteenth plate of his second volume, may give a tolerable notion of this curious animal.
16. and 17. Are different views of a madrepora porpites found in the same bed at Bradford.
19. Seems to be a madrepora
18. Is a view of its radiated termination.
20. Has been considered by some attentive observers as an actinia. Many of these have been discovered corrugated, and distended, others flattened and incurvated, but never fractured, and therefore they must have been soft and pliable, like the actinia, not brittle like the coral.
21. Is the reverse of 22. and seems to be a species of madrepora.
23. and 24. Are different views of a turbo belonging to this bed of white clay at Bradford.

PLATE XII.

Fossils of the inferior Oolite.

Fig. 1. 2. 3. Are cunei from Petty France.
4. Is an arca noæ from Sodbury.
5. and 6. Are different views of a patella from Hampton Common, Glocestershire.
7. and 10. Are turbinites from Rodborough-hill.
8. Is a buccinite. Fig. 9. Is Helix. Fig. 11. Is trochus imbricatus from Petty France.

PLATE XI.

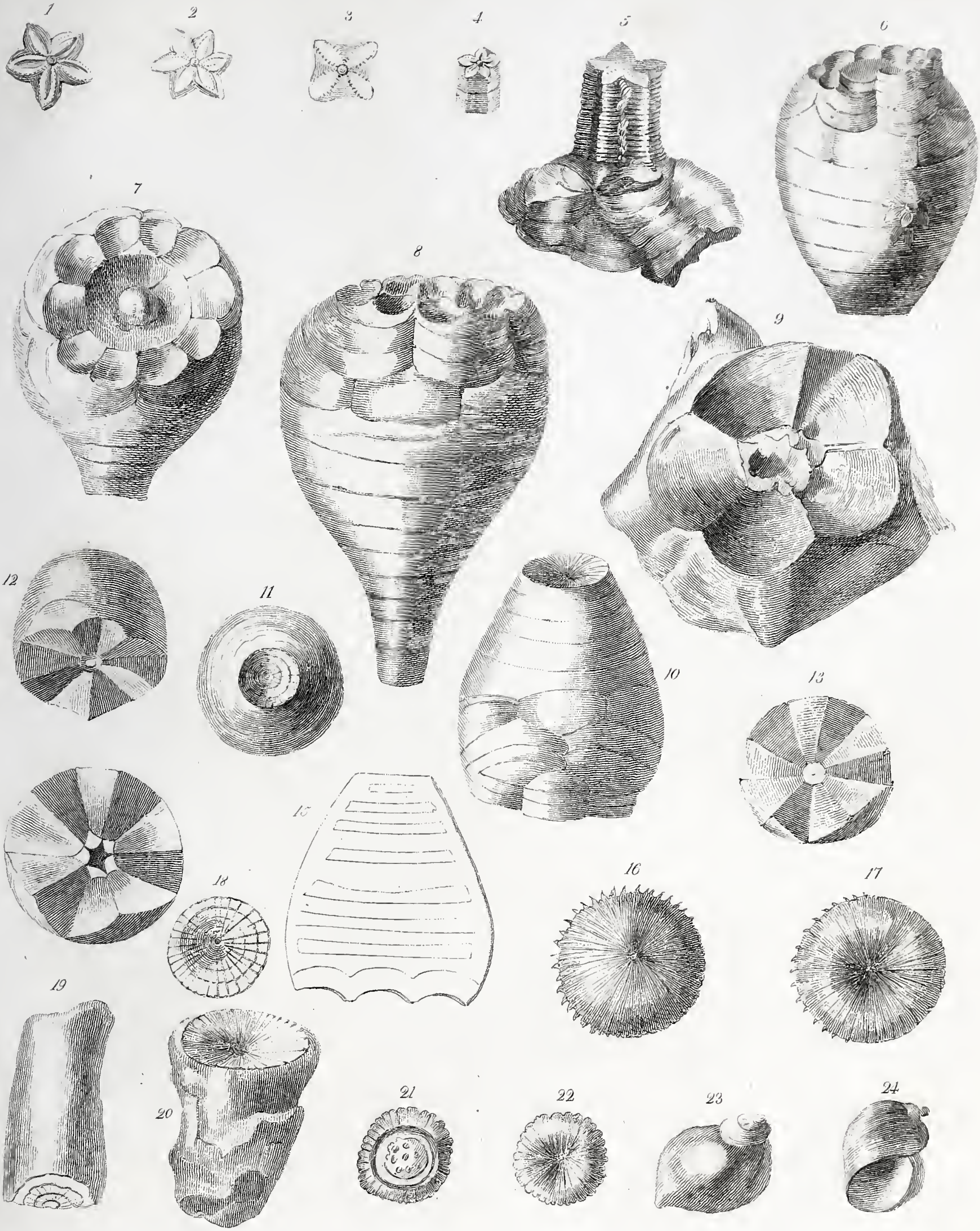

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PLATE XII.

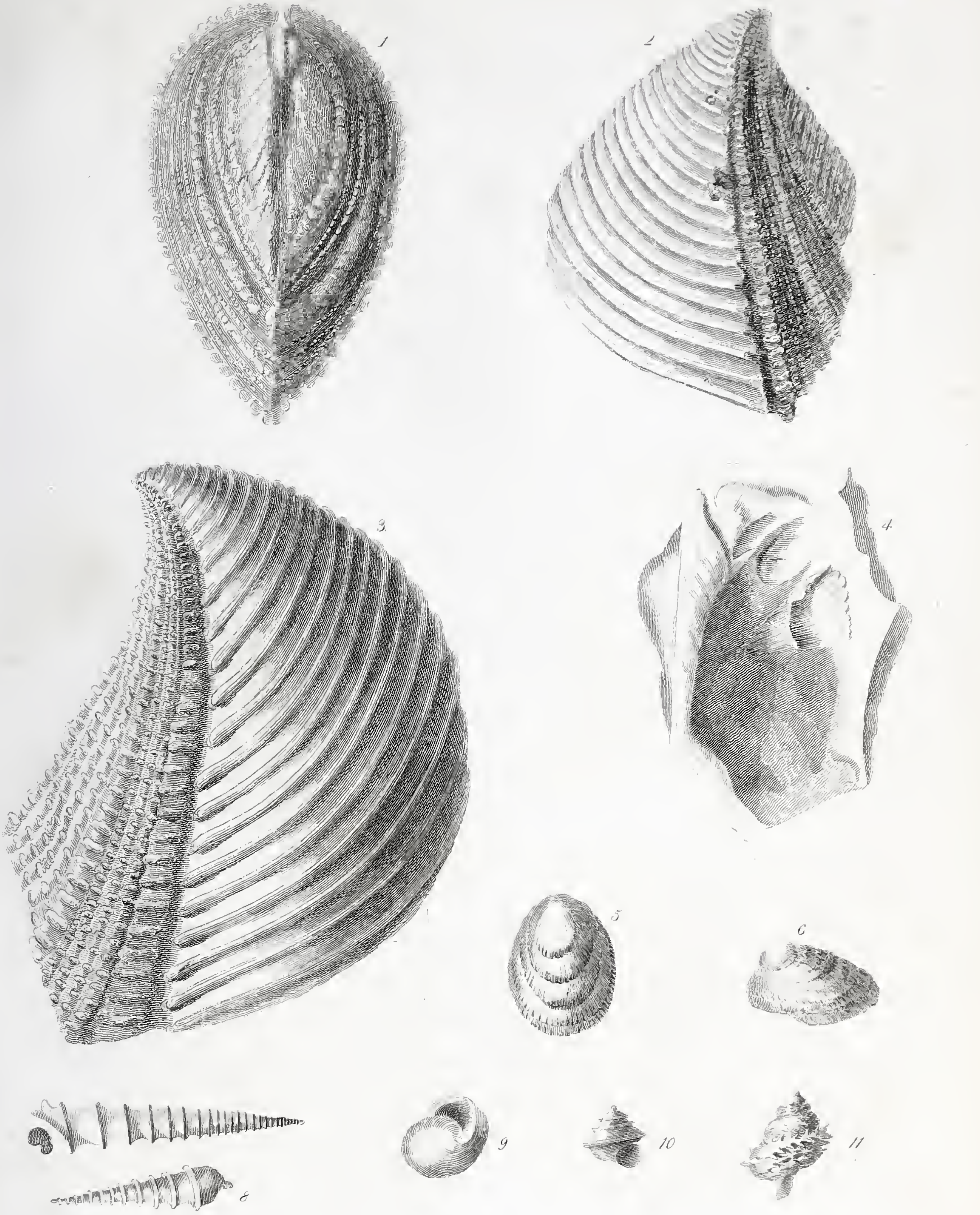

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PLATE XIII.

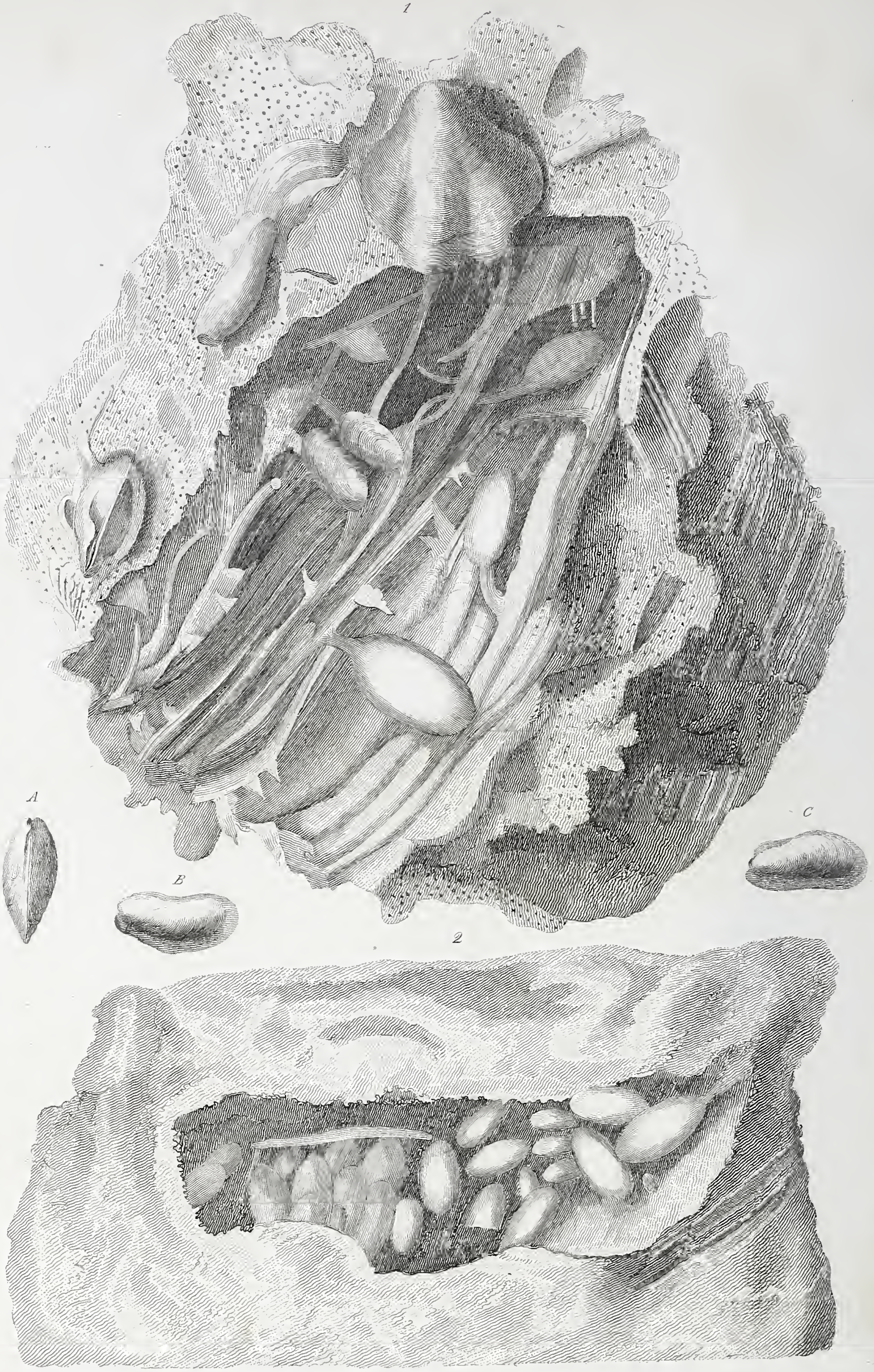

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PLATE XIV.

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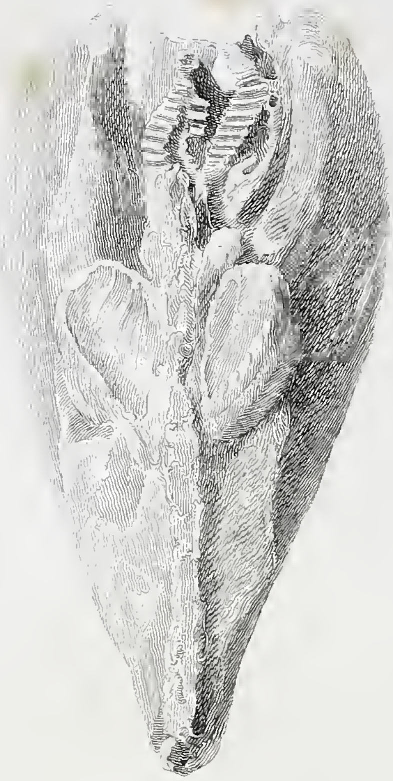

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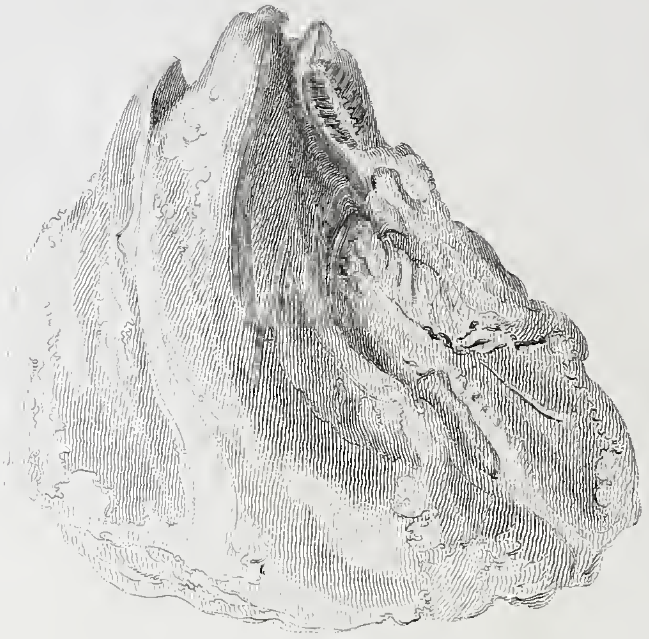

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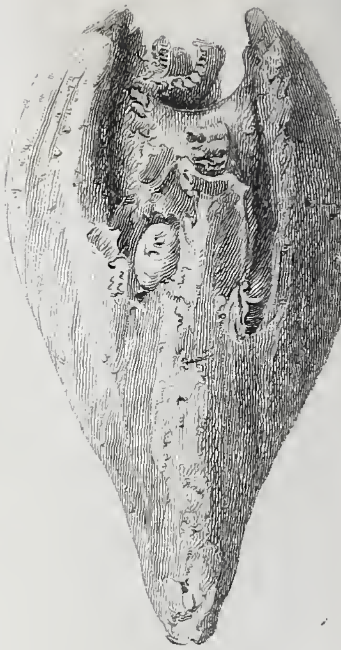

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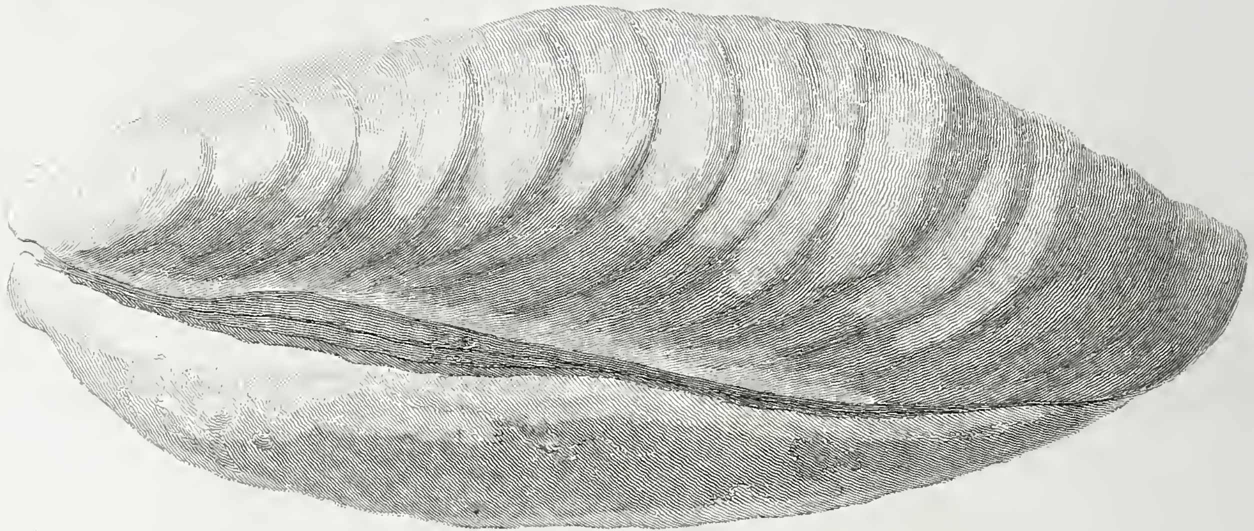

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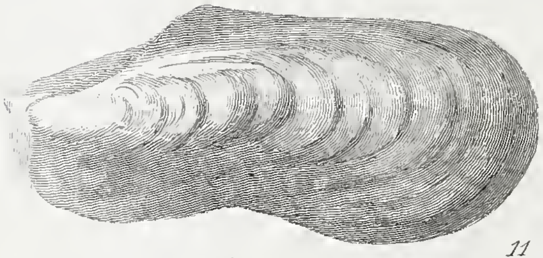

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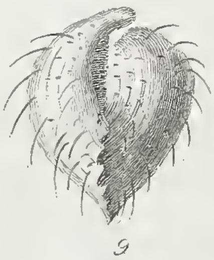

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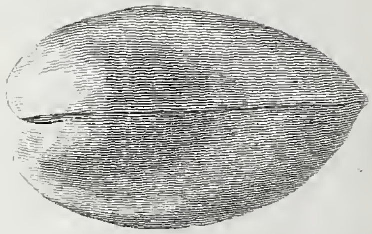

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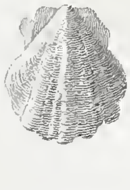

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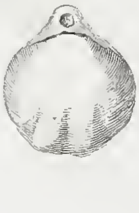

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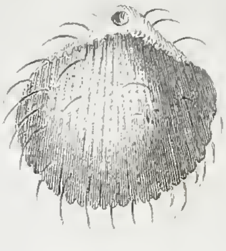

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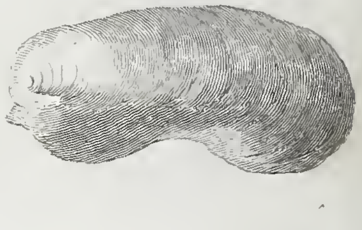

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PLATE XIII.

Fossils of the inferior Oolite continued.

Fig. 1. Internal view of a large fragment of a pectinite forming a cavity, in which are many coated mytili with their cables, and some cables without their mytili. This curious fossil was found in evcavating the canal between Stokebridge and Bradford. On the upper part of the cavity is a terebratula.

2. Fragment of the rock with a cavity containing twenty-four of these coated mytili. It was found at Mitford, and is in the possession of Thomas Meade, Esq. of Chatley-house, near Philip's-Norton. A. B. C. are different views of this mytilus.

PLATE XIV.

Fossils of the inferior Oolite continued.

Fig. 1. 2. 3. Are commonly called hippocephaloides or horsehead muscles. They appear to be not casts, but petrifactions of the fish itself, and do not represent the interior surface of the shells, from which they are perfectly distinct.

4. Is a mytilus, but of what species it is impossible to say.

5. and 6. Are different views of mytilus modiolus, found at Bath, in the cliff of Mount-Beacon, near Camden-Place.

7. Should have been referred to some stratum connected with the grey sand bed of Portland island.

8. and 9. Are anomia spinosa of Linnæus which are well figured by Knorr, p. II. B. IV. f. 4. In some specimens the delicate spines are more than half an inch in length.

PLATE XV.

Fossils of the inferior Oolite continued.

Fig 1. Ostrea gibba of Linnæus found in the bed of calcareous sand, which is under this bed of Oolite at Ensham, Ilminster and Yeovil.

2. 3. and 4. Are oysters from Hampton Down in Glocestershire.

PLATE XVI.

Fossils of the blue Lyas Beds and of the intermediate Clay.

Fig. 1. and 2. Are considered as Venus shells: but I never have been so fortunate as to discover the hinge. Figure 2. may be a donax.

PLATE XVII.

Fossils of the blue Lyas continued.

Fig. 1. and 2. Are ostrea gryphus from Bath Weston, found in the clay which separates the beds of lyas.

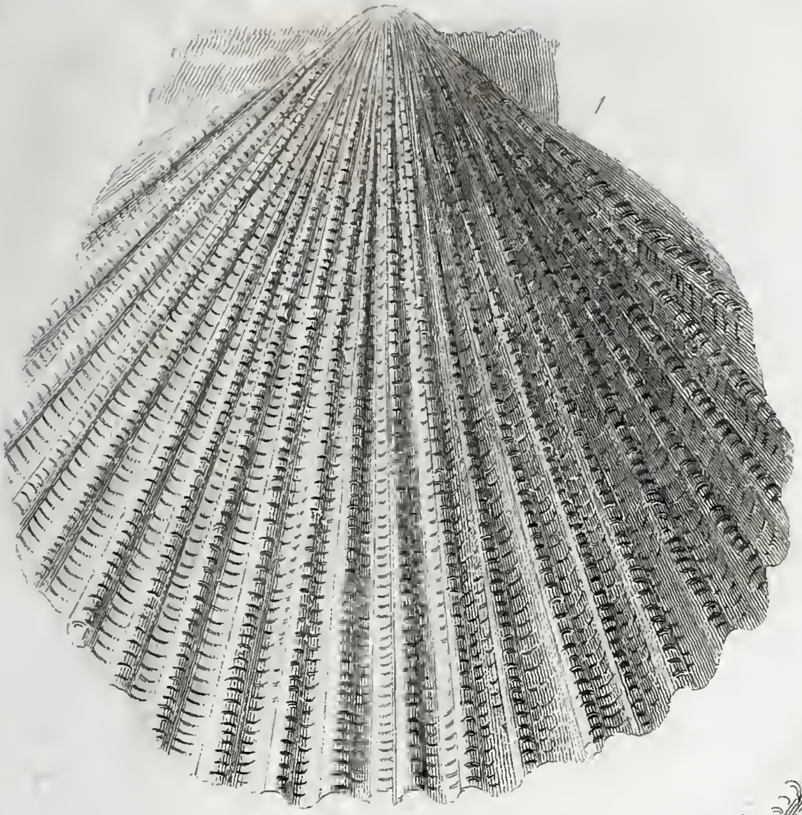
3. An oyster very common in the lyas beds. It is well figured by Knorr, pl. II. suppl. v. 4.

4. May be a venus or a donax. These abound in the substance of the lyas, in the neighbourhood of Bath.

5. A very curious anomia, first particularly noticed by John Walcott, Esq. He met with it near Camerton. I have collected this interesting fossil from various parts, but never saw it in any rock stratum, except the lyas.

6. 7. and 8. Represent different views of the interior of this fossil. All that I have seen, perfectly resemble this. It is hollow and uniformly exhibits a similar opening into the cavity. It is not therefore a cast, but is intirely composed of transparent chrystals of calcareous spar. A good Conchologist has denominated this shell *anomia arcoides*, I should have been disposed to call it *anomia hysterita*, if that term had not been already occupied by a different species found fossil in some parts of Germany.

PLATE XV.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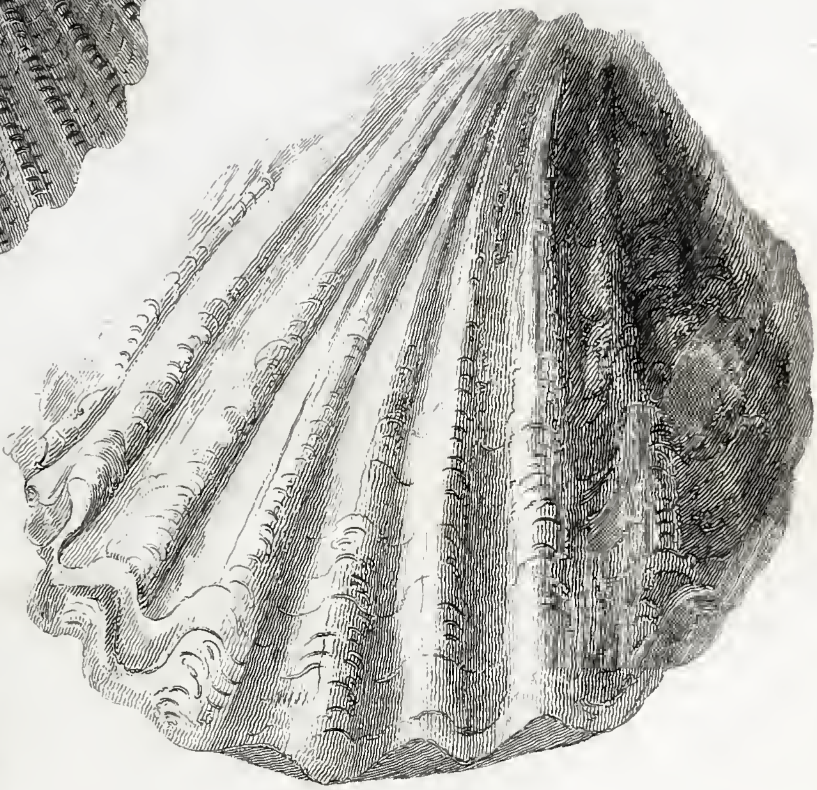
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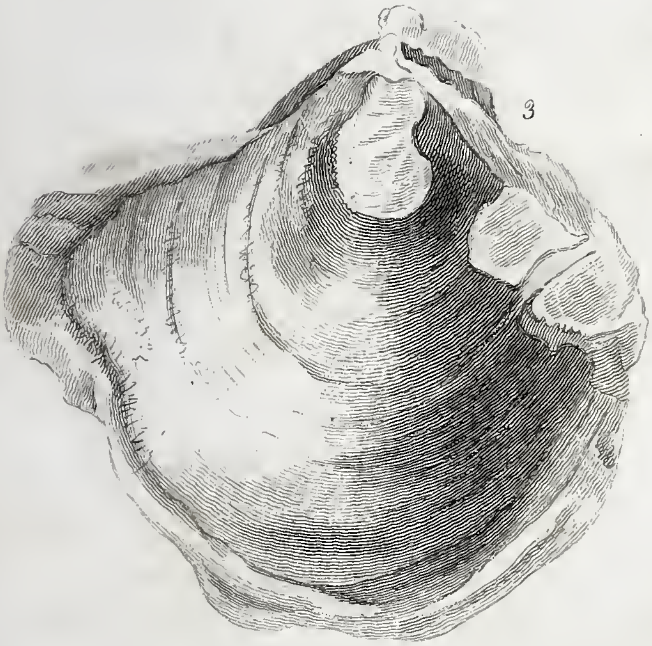
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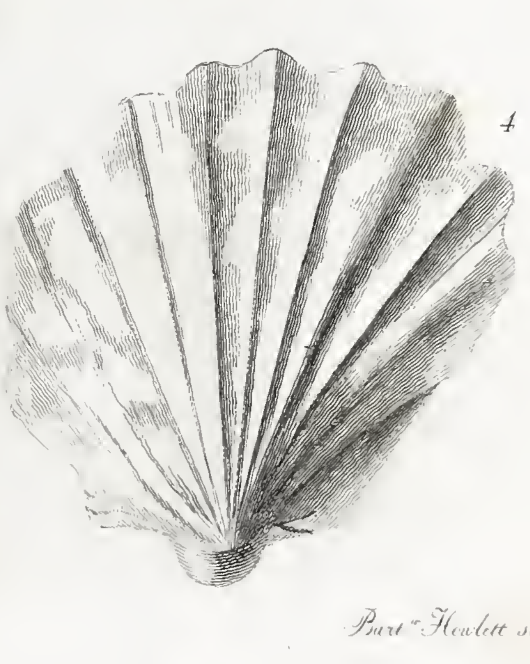
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Rev^d Jos^h Townsend delin.

Bart^w Howlett sculp.

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PLATE XVI.

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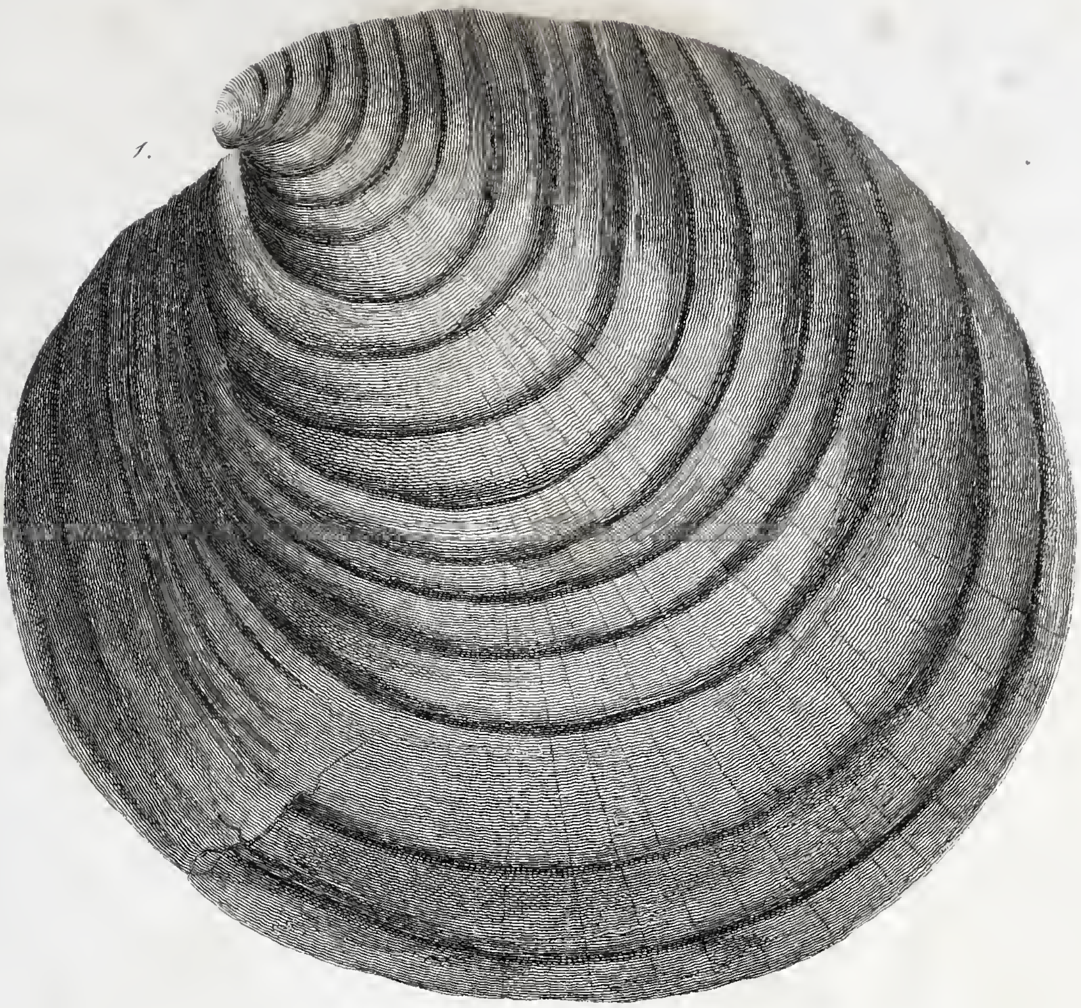

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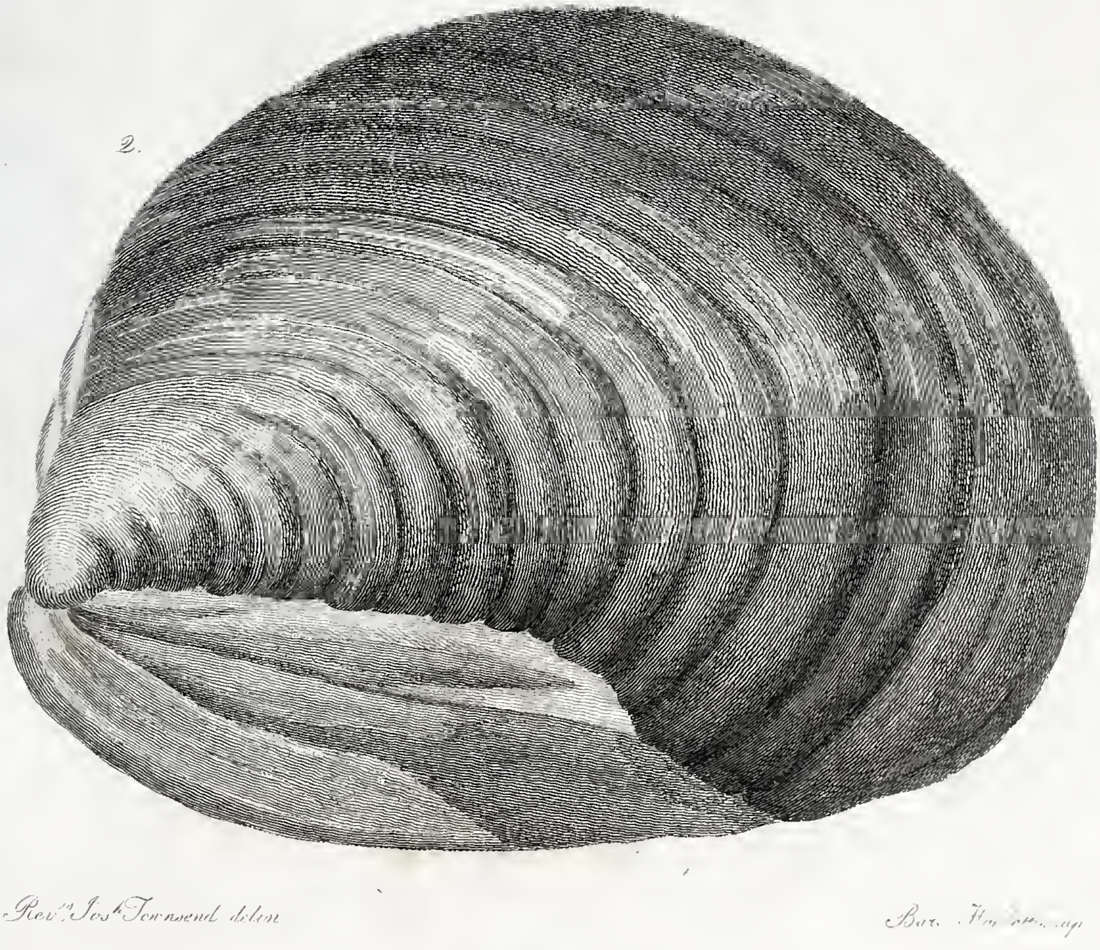

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Bar. Howlett sculp

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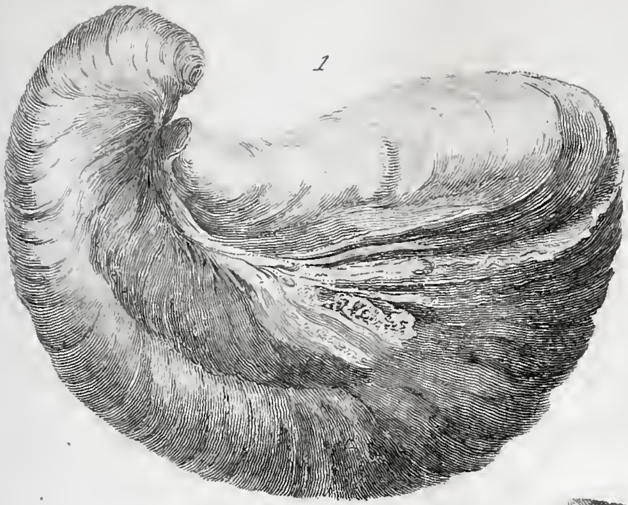
PLATE XVII.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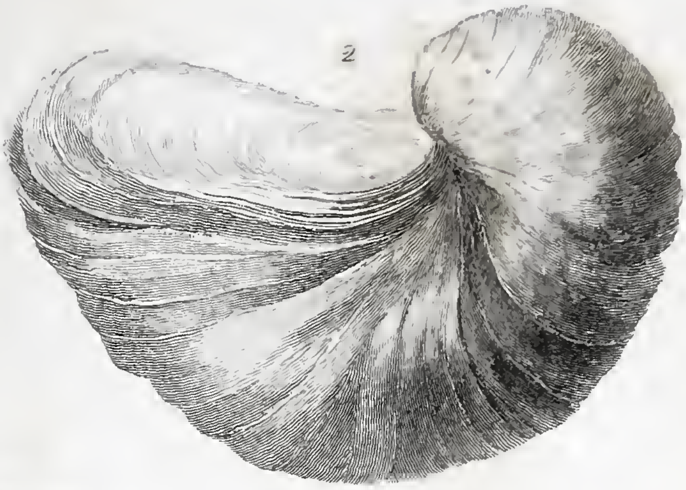
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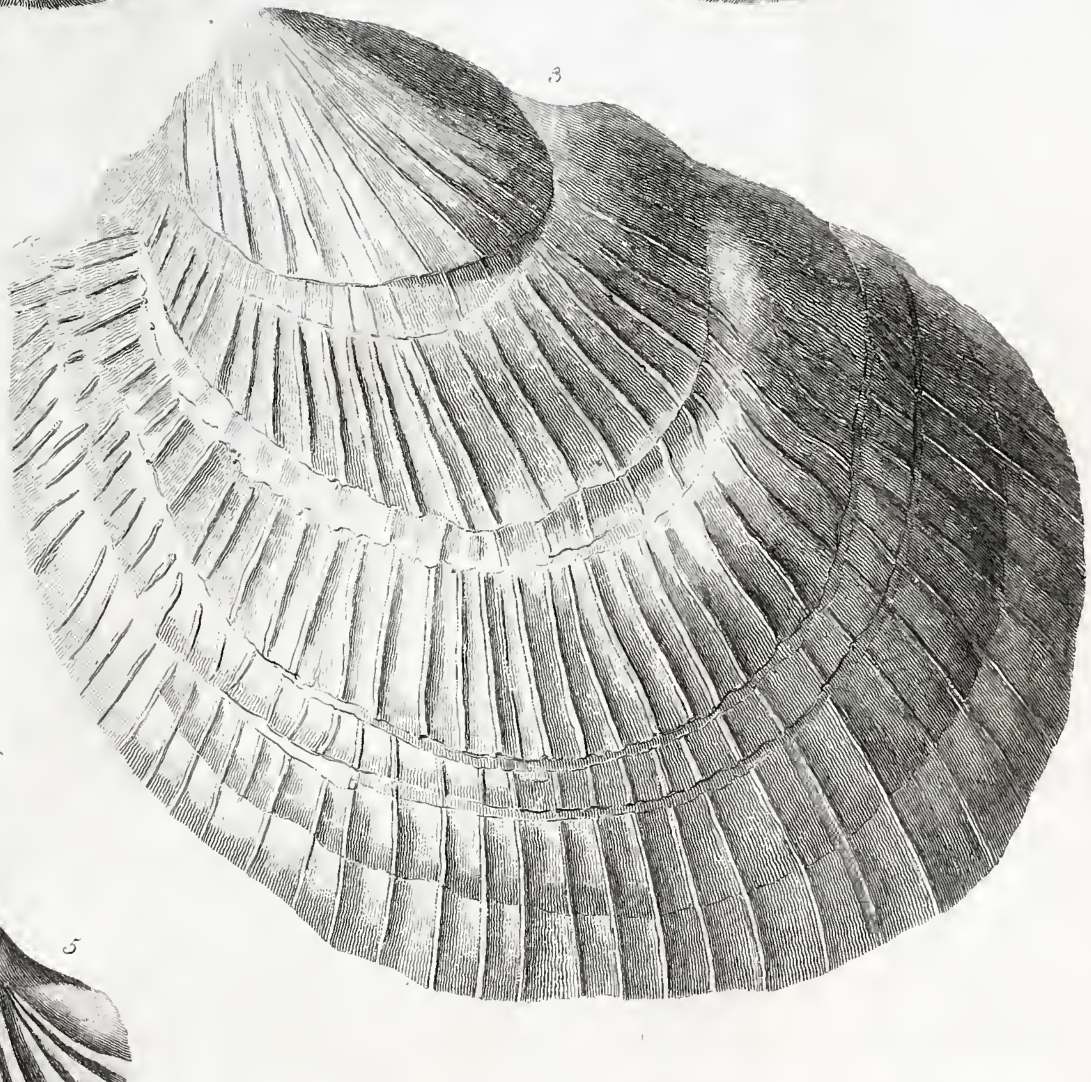
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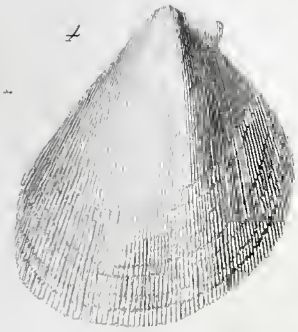
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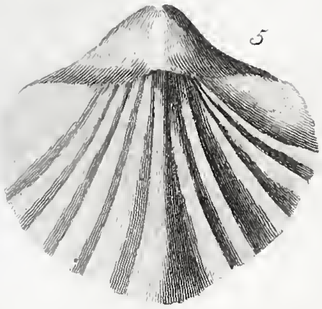
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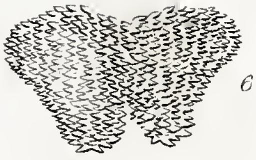
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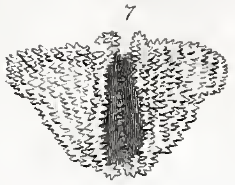
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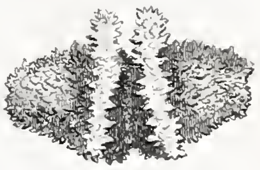
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Bart Howlett sc.

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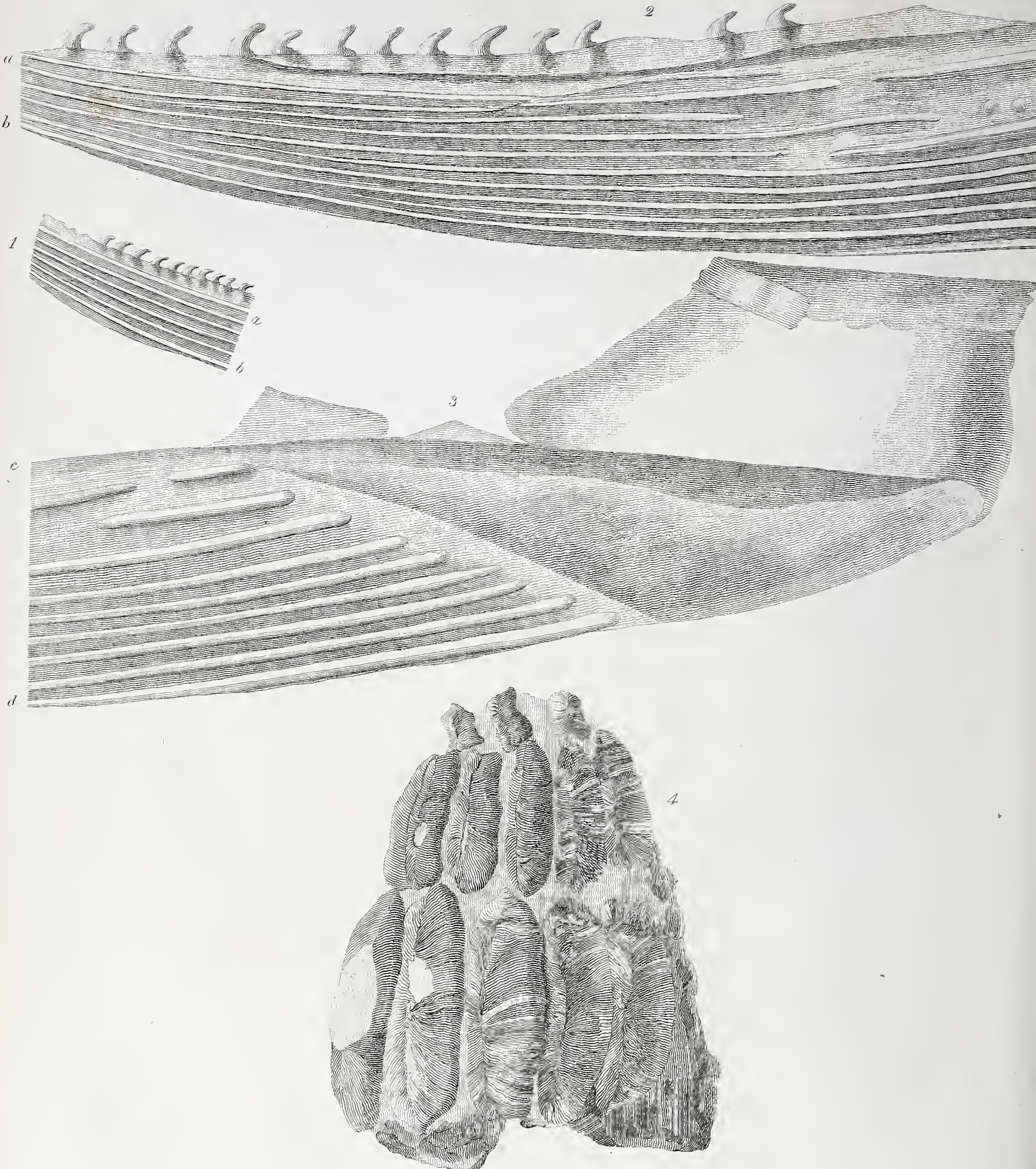
PLATE XVIII.



Revd. Josh. Townsend delin. *Bartw. Howlett sculp.*

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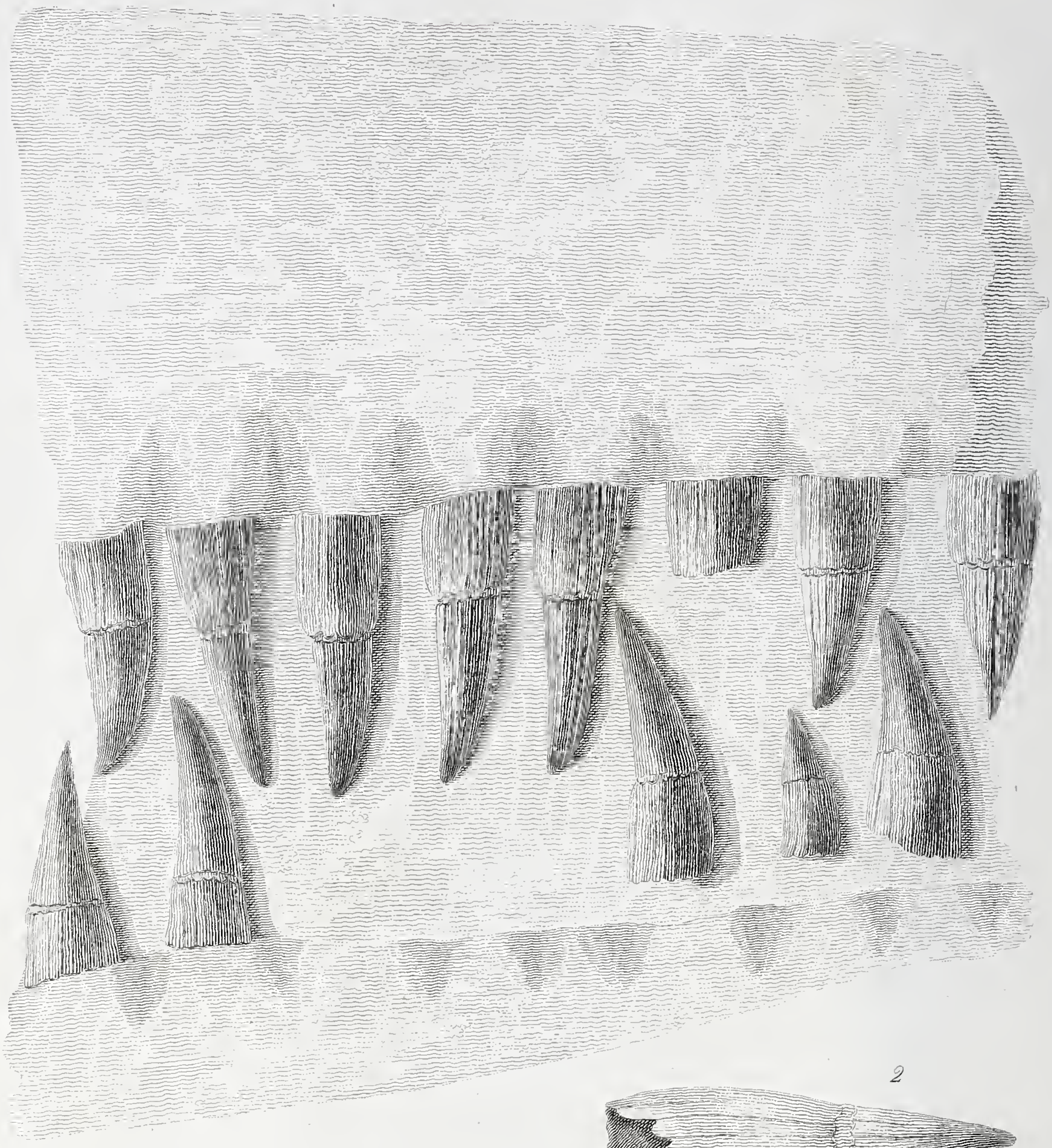
PLATE XIX.

1.



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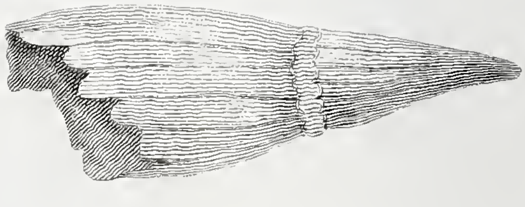

Revd. Josh. Townsend delin

Bartw. Howlett sculp

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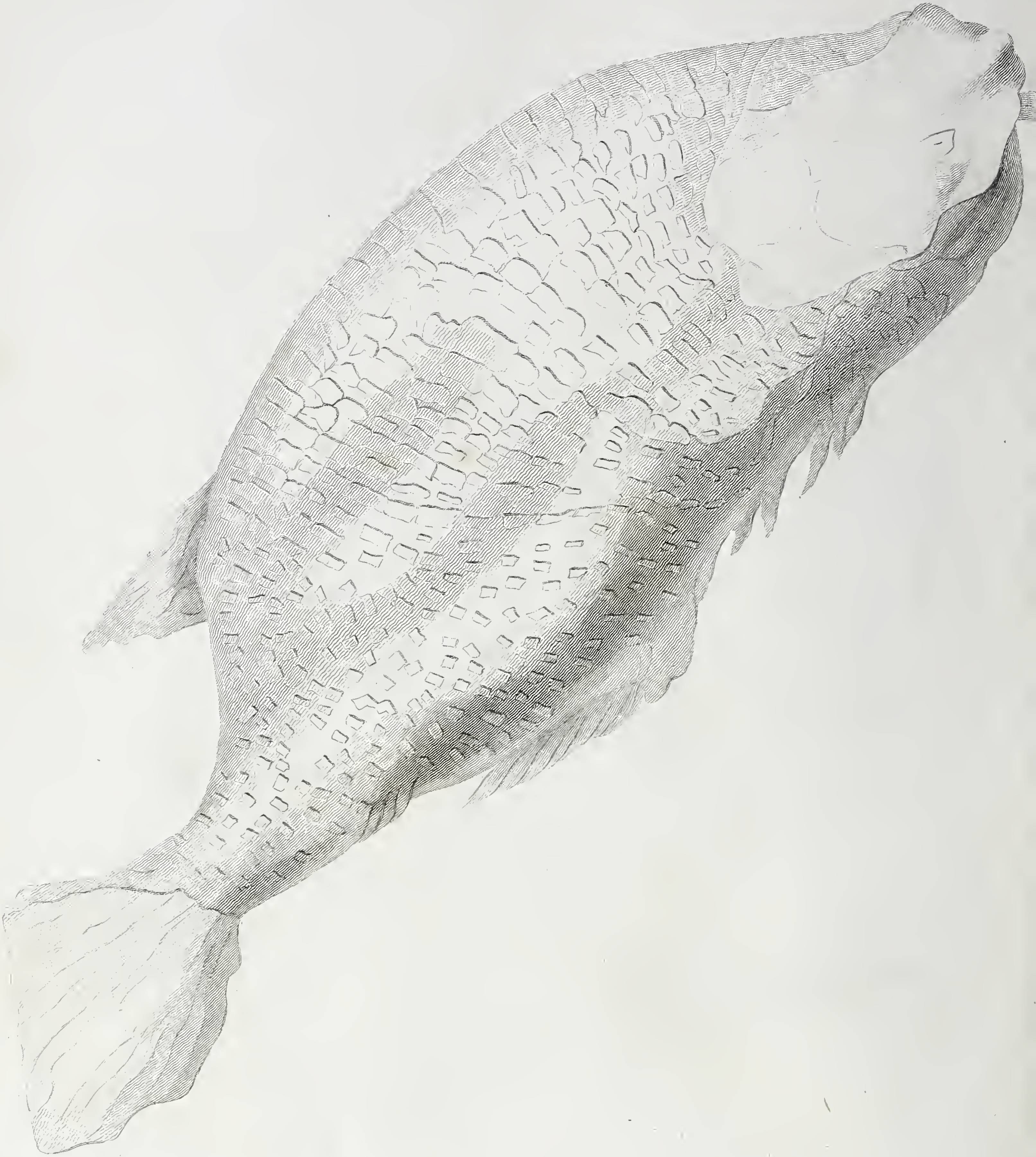
PLATE XX.



Revd. Josh. Townsend delin

Bartw. Howlett sculp

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PLATE XVIII.

Fossils of the blue Lyas continued.

Fig. 1. 2. 3. Are the three portions of a jaw, which, when united, form the exact representation of a jaw fifteen inches and a half in length. I obtained it from one of the pits of Bath Weston. Similar jaws are in the cabinets of Jacob Wilkinson, Esq. near Bath, of William Broderip, Esq. in Bristol, and in the public library there. All the teeth are so formed as to enable this animal to catch its prey. But no provision is made for manducation : consequently whatever it caught, it swallowed whole.

4. Is copied from Mr. Walcott. I have many siliquastra, but not arranged as in the specimen here produced.

PLATE XIX.

Fossils of the blue Lyas continued.

Fig. 1. Part of a jaw supposed by Mr. Bullock to be of the Gangetic Crocodile. It was found in a thick bed of the lyas, and is in the possession of the Rev. Peter Hawker, Rector of Woodchester, in Glocestershire.

2. A tooth in the possession of Mr. Wilkinson.

PLATE XX.

Fossil fish found in the white lyas in Glocestershire, seven miles from Bath. It is the property of Mr. Trotman. I have seen many fragments of this fish, but never saw one entire, till I saw this.

PLATE XXI.

Fossils of the Mountain Lime Stone.

Fig. 1. View of a shell which W. Martin calls *anomites cuspidatus,* and thus describes. Valves convex, hinge strait, patulous, triangular, divided down the middle by a large perpendicular foramen in form of an acute isoceles triangle, twenty-eight or thirty strong furrows crossed by wrinkles. A deep rounded sinus destitute of furrrows in the larger valve, answered by a convex wave on the lesser valve, and terminated by a strong curvature at the margin.

2. Is the reverse of the same shell. Martin's figures are generally good : but in plates 46, and 47. he fails in his perspective, and had I not seen a specimen of this curious shell in the cabinet of my friend Wm. Broderip, I should have had no adequate notion of it. My figures are taken from Mr. Broderip's fossil, which came from the black rock, or encrinus bed of the mountain lime-stone at Clifton, and is most remarkable, because part of the shell is unchanged, white, smooth, and shining. In my figure the isoceles triangle, a, c, d, represents the foramen, in which the black lime-stone appears. The other triangles, in a, b , c, and a, d, e, in this specimen, are shell as perfect as when recent.

3. Is taken from Knorr, and seems to have a similar foramen.

4. A. B. and C. are different views of a shell which Wm. Martin in his Petrifacta Derbiensia describes as conchyliolithus, (productus) Anomiæ testa longitudinaliter striata, Cardine recto, valvula altera producta, cylindrico-convexa, altera brevi plana. A. exhibits a side view of the entire fossil ; B. a front view of the same ; C. a front view of the fossil without its fragment, 6. A. and B.

6. A. Is the convex face of this fragment separated from C.

6. B. Is the concave view of the same.

7. Represents a side view of another specimen without it's cap.

8. Is a view of this cap, which exactly fits on figure 7. and, being placed on it, perfectly conceals it.

9. A. B. and C. Represent a fragment, of which A. and B. are the superior surface, and C. the inferior. This fragment has the appearance of a bivalve, but it is in reality merely a part of such a fossil as I have here described. I have one specimen resembling this, but larger and retaining the iridescent colours of the original shell. These are from the Wreakin. Besides these I have also several fragments of a similar fossil, from Clifton, in red marlstone.

10. Is a species of anomia peculiar to this rock.

11. Is from the Wreakin and I flatter myself is correct. In Martin the figure is inaccurate.

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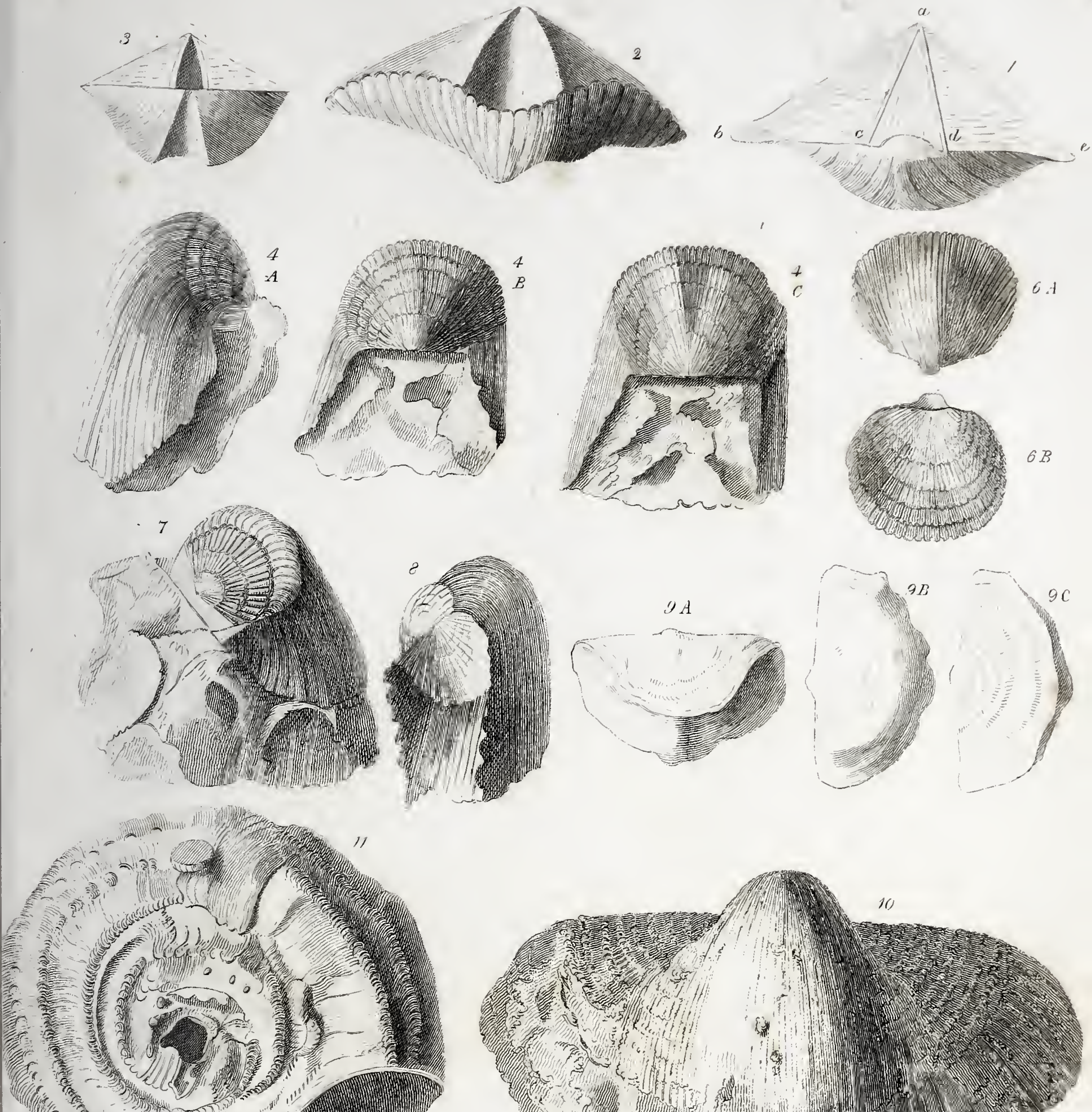
PLATE XXI



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